BULLETIN

OF THE

Society for the Promotion of Engineering Education

Published under the supervision of the Publication Committee:

Henry S. Jacoby, Anson Marston, F. L. Bishop, *Editor*.

Address all communications to the Editor, University of Pittsburgh, Pittsburgh, Pa

VOL. VI LANCASTER, PA., JUNE, 1916 No. 10

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EDITORIAL.

Attendance at the Annual Meeting.—Why should every member of the Society consider more carefully than before the question of attending the annual meeting of the Society this year? There are several reasons. Last year, upon the recommendation of the Council, the Society adopted a new policy with reference to its committee work, believing that thereby it can render more effective service in the promotion of engineering education. The first series of reports is to be made at this meeting in accordance with the decision of the Council. Ample time is to be given to the discussion of reports. A large attendance of members is necessary to get the most profitable discussion. The Society cannot afford to have this experiment fail because the experience of two other national societies has demonstrated the effectiveness of the plan. Another new society has also adopted it. It is therefore the duty of every member who can possibly arrange to make the journey at that time to attend the meeting.

Members who attend the annual meeting receive important benefits apart from hearing reports, papers or discussions. To extend one's acquaintance with members from other educational institutions pays well for the time and expense involved. This year, it is confidently expected, there will be a larger number of representatives from the engineering colleges of our "Southland" than at any previous meeting of the Society. This affords an unusual opportunity for members from other parts of the country. To be able to enjoy the

hospitality of the University of Virginia under such delightful conditions; to have a chance to study the spirit and aims of that institution, and to examine its buildings and equipment, materially enlarges the benefits to be derived by attendance at the meeting.

Institutional membership has now developed sufficiently to undertake plans for constructive work. Through its influence a larger number of administrative officers become acquainted with the work of the Society. The Society will probably be called upon to make studies which will be of direct service to the institutions represented. The policy to be adopted to make institutional membership of the most value will receive consideration. The Society needs the help of all its members, especially of those who have contributed to its successful achievement in the past. The others ought to come to the meeting to learn of its plans and how they may help in the future. What one receives from the Society is proportional to what one puts into it.

Whatever time is not needed at the sessions for committee reports and discussions will be devoted to the presentation of papers.

HENRY S. JACOBY.

SOCIETY NOTES.

TREASURER'S STATEMENT OF RECEIPTS AND DISBURSEMENTS.

Cash received, to May 2, 1916:		
Back dues	$ 563.50	
Current dues	4,414.25	
Advertising and Sale of Publications	1,077.46	
Cash on hand, June 17, 1915 (including Life Membership Fund)	1,038.32	
Total		$7,093.53
Disbursements:		
Schedule *A*,	$ 247.85	
B,	1,156.43	
C,	1,266.33	

D,	141.58	
H,	490.00	
I,	444.67	
J,	222.65	
K,	35.02	
L,	38.28	
M,	90.71	
Accounts Payable, due from last year	643.96	
Secretary's Salary, 1915–1916	200.00	
Asst. Secretary's Salary, 1915–1916	100.00	
Treasurer's Office, 1915–1916	228.26	
Increase, Secretary's Petty Cash	50.00	
Paid New Era Printing Co., on account	500.00	
Miscellaneous	24.00	
	$5,879.74	
Less discount	29.03	5,850.71
Balance (including Life Membership Fund)		$1,242.82

CONVENTION NOTE.

Editor's Note.—The following letter will be of interest to all who expect to attend the Virginia meeting, whether they go by automobile or by rail.

To the Secretary,

Dear Sir: I beg to thank you for the information in regard to expenses for the annual meeting. Arrangements are progressing nicely in all ways and we are looking after the annual dinner and other functions.

You speak of coming through by motor car and I thought possibly the following information might be acceptable in regard to route, etc.

I have obtained information in respect to the roads from Cumberland, Maryland and from Washington. I expect you will come via Cumberland so I simply note the roads from that point.

Cumberland to Hagerstown. New State Road. No tolls, excellent road.

Hagerstown to Martinsburg on Martinsburg Pike. Excellent.

Martinsburg to Winchester on Winchester Pike. Excellent.
Winchester to Staunton on Valley Pike.

Between Hagerstown and Staunton there are some 30 toll gates, with an average toll of 15 cents.

An excellent inn, "The Wayside Inn" at Middletown, between Winchester and Strasburg.

Staunton to Charlottesville on post road. This road is very good with the exception of a few miles just before reaching Charlottesville. There is a good inn, "The Green Tea-Pot" between Afton and Greenwood.

The route outlined above furnishes excellent roads for the most part and the scenery is superb throughout the valley.

The following outline will show you the scheme for the trip through historic Virginia after adjournment, with probable cost per person. I trust you will let us know just what you think of the proposed trip, its feasibility and whether or not, in your judgment, there will be a good number of the delegates who will take the trip. As outlined it should furnish a somewhat unusual opportunity for seeing this most interesting section at a rather low cost.

The trip itinerary is as follows:

Leave Charlottesville, Thursday morning about 10, over the C. & O. Ry. for Richmond. Arrive Richmond about 1 P. M. Motor to Jefferson Hotel for lunch. Sight-seeing tour of Richmond in the afternoon. Dinner at Jefferson Hotel. Stay the night at Jefferson Hotel and have breakfast early.

Take chartered steamer in early morning and steam down the James River to Jamestown Island, reaching there in early afternoon, luncheon on steamer. View historical sights and then motor to Williamsburg and see historical features.

By rail from Williamsburg to Old Point Comfort, having dinner at the Chamberlain Hotel, and staying the night there, breakfast at the Chamberlain and disperse at the pleasure of the members.

The estimated cost is as follows, special prices having been obtained on practically all items.

Fare to Richmond	$2.00	
Motor to Hotel	.25	
Sight-seeing trip in Richmond	1.00	
Jefferson Hotel: Lunch, dinner, lodging, breakfast ($4.00 for room without bath)	4.50	room with bath
Motor to steamer	.25	
Steamer (chartered for $300), assuming 150	2.00	
Luncheon on steamer	1.00	
Motor to Williamsburg	.50	(?) possibly $1.00
Fare to Old Point Comfort	1.00	
Hotel Chamberlain: Dinner, lodging, breakfast	3.00	
	$15.50	

In round numbers about $16.00 for the trip.

You will note the necessity of leaving for Richmond at 10 A. M. on Thursday in order to have sufficient time for the Richmond points of interest. I trust it may be possible to so arrange the meetings that this can be done, if the trip is undertaken.

Hoping to hear from you as soon as possible in regard to this trip feature, in order that it may be carried out smoothly, I beg to remain,

Very cordially yours,

WALTER SHELDON RODMAN.

HENRY S. JACOBY.

President Society for the Promotion of Engineering Education, 1915–1916.

Professor Jacoby is a civil engineering graduate of Lehigh University, class of 1877. After graduation he joined the topographical corps of the second Pennsylvania Geological Survey and remained for about a year and then became transitman on the gaging of the Red River and Atchafalaya River surveys. He left this work to become chief draftsman in the United States Engineer's Office, a position which he held from 1879 to 1885.

He returned to Lehigh University in 1886 as an instructor

in civil engineering and remained until 1890. He then went to Cornell, first as assistant, then as associate and finally as a full Professor of Bridge Engineering and Graphics, the position which he still holds.

As an author he has written books on descriptive geometry and lettering, a book on "Structural Details, or Elements of Design in Timber Framing" and is joint author with Professor Mansfield Merriman of "Roofs and Bridges," in four parts, and has contributed freely to the technical journals.

He was Secretary of the SOCIETY, 1900 to 1902, and has always taken an active interest in its work. During his term as President of the SOCIETY, Professor Jacoby has been especially active in furthering and encouraging the work of the Committees.

EDWIN ANDERSON ALDERMAN.

President, the University of Virginia.

Edwin Anderson Alderman was born at Wilmington, N. C., May 15, 1861. He graduated from the University of North Carolina in 1882. The degree of Doctor of Laws has been conferred upon him by the University of the South, Tulane, Johns Hopkins, Columbia, Yale, University of North Carolina, Williams, Dartmouth, Harvard and the University of Pennsylvania.

He was superintendent of schools, Goldsboro, N. C., 1884–7; assistant state superintendent of schools in N. C., 1889–92; professor of English, N. C. State Normal College, 1892; professor of education, University of N. C., 1892–96; president, University of N. C., 1896–9; president, Tulane University, 1899–04. In June, 1904, he was appointed as the first president of the University of Virginia.

Doctor Alderman's activities are well shown by the following list of associations with which he is affiliated: Member of Southern Education Board; Member of General Education Board; Vice-President National Education Association, 1903; Member of Virginia State Geological Commission; Member of

Rockefeller Sanitary Commission; Member of Virginia State Educational Commission; Member of Council of American Association for International Conciliation; Member of Board of United States Military Academy, West Point, 1893; Member of Executive Council of American Civic Alliance; Member of Maryland and Louisiana Historical Societies; Member of Century Club, New York, 1912; Member of American Academy of Sociological Sciences; Director of Southern Railway.

Doctor Alderman is author of the following: "A Brief History of North Carolina," "Life of William Hooper," "Life of J. L. M. Curry," "Obligations and Opportunities of Citizenship," "Southern Idealism," "The Spirit of the South," "Sectionalism and Nationality," "The Growing South," and Editor-in-Chief of "Library of Southern Literature."

NEW MEMBERS.

CARMICHAEL, F. L., Assistant Professor of Mathematics, University of Alabama, University, Ala.

COAHRAN, J. M., Professor of Electrical Engineering, Villanova College, Villanova, Pa.

FOLWELL, A. P., Managing Editor, Municipal Journal, Montclair, N. J.

JOHNSON, F. E., Assistant Professor of Electrical Engineering, University of Kansas, Lawrence, Kans.

LITTLE, G. T., Power Plant Operation, Stone & Webster Management Association, Pawtucket, R. I.

MCCOMB, DANA, Practicing Civil Engineer, 500 West 122d St., New York, N. Y.

SALE, C. S., Assistant to Director, Enginering Experiment Station, Instructor in Civil Engineering, University of Illinois, Urbana, Ill.

TERRILL, A. C., Head, Department of Mining Engineering, University of Kansas, Lawrence, Kans.

WOLFE, W. S., Instructor in Architectural Engineering, University of Illinois, Urbana, Ill.

AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS, College Station, Tex., Wm. Bennett Bizzell, President.

OBITUARY.

KARL EUGEN GUTHE.

Karl Eugen Guthe was born in Hanover, on March 5, 1866. He received his preparatory education in the Hanover Gymnasium and Technical School. He later studied at the Universities of Strassburg, Berlin and Marburg, receiving his degree of Doctor of Philosophy at the last in 1892. In the same year he came to the United States. For ten years he taught physics in the University of Michigan. In 1903 he entered the service of the United States government as associate physicist in the Bureau of Standards. Two years later he became head of the department of physics in the State University of Iowa.

In 1909 Dr. Guthe returned to the University of Michigan as professor of physics following the retirement of Dr. Carhart.

In 1912 he became dean of the graduate department, which position he held until his death, September 10, 1915.

Dr. Guthe became a member of the Society for the Promotion of Engineering Education in 1914.

BOOK REVIEW.

Text Book of Mechanics. Vol. 6. Thermodynamics. By L. A. MARTIN, JR., Professor of Mechanics, Stevens Institute of Technology. John Wiley & Sons, Inc., publishers. 5 x 7¼, 313 pages, 78 figures. Cloth. $1.75 net.

This volume forms the sixth of a set of textbooks on mechanics, the first five volumes being on statics, kinematics, mechanics of materials, applied statics and hydraulics. The material in the textbook is admirably arranged and should well fulfill the author's object to produce a text which will encourage the student to think and not to memorize. Practical applications of the principles involved are made throughout the text and these together with problems form an excellent ground work in the first principles of the subject.

J. W. H.

THE UNIVERSITY OF VIRGINIA—III.

BY WALTER SHELDON RODMAN,

Associate Professor of Electrical Engineering.

By an act of the legislature of Virginia, dated January 12, 1803, certain citizens of Albemarle County were incorporated under the style of "Trustees of Albemarle Academy," and were empowered to take such steps as seemed practicable to raise the funds necessary for erecting buildings and putting the academy into operation. Albemarle Academy was destined never to exist except on paper, but under the guidance of Thomas Jefferson, who was elected to the board of trustees on March 23, 1814, a process of development was begun leading first to the organization of Central College, and afterwards to that of the University of Virginia. On August 19, 1814, the committee of the trustees appointed to select a site, reported that it would be desirable to locate the academy in the vicinity of the town of Charlottesville, distant not more than half a mile therefrom.

By an act of February 14, 1816, the Legislature authorized the establishment of "Central College, in the County of Albemarle, at the place which has been, or shall be, selected by the trustees of Albemarle Academy, and in lieu of such academy." All rights and claims of Albemarle Academy were, by the same act, vested in Central College. The board of visitors of the college consisted of six members, of whom Jefferson was the only one who had been a member of the academy board. The other five members were James Madison, James Monroe, Joseph Carrington Cabell, David Watson, and John H. Cocke.

On May 5, 1817, Jefferson was elected rector of the board, and, on the same day, the board authorized the purchase of a farm of about two hundred acres lying one mile west of Charlottesville as a site for the college. This tract now forms a part of the grounds of the University of Virginia.

EDWIN ANDERSON ALDERMAN.

President of the University of Virginia.

(See page 679.)

The cornerstone of Central College was laid on October 6, 1817, in the presence of Thomas Jefferson, Rector, and of James Madison and James Monroe—the latter then President of the United States. This building, located on what is known as the West Lawn of the University, is now utilized as the Colonnade Club.

Jefferson's plan was to erect a distinct building, a "pavilion," for each individual professor—buildings to be arranged around a rectangular lawn. Each pavilion was to contain "a schoolroom and apartments for the accommodation of the professor," and one-story dormitories for the students were to be erected adjacent to the pavilions. Jefferson drew most of the sketches for the buildings with his own hands, basing them upon designs by Palladio; and his ideas of architectural effect and grouping were carried out in detail when Central College was merged into the University of Virginia.

The prime object in Jefferson's mind, while rector of the board of visitors of Central College, was to get the college well under way, and then have it adopted by the legislature as the state university. Accordingly, in the first report of the visitors to the legislature, on January 6, 1818, it is recommended that a state university be established on the site of Central College.

By an act of February 21, 1818, the legislature authorized the appointment by the governor of a board of twenty-four members, to be known as the "Board of Commissioners of the University." It was the duty of this board to meet on August 1, 1818, at the tavern in Rockfish Gap, on the Blue Ridge Mountains, and report upon the following points regarding the organization of a state university:

1. A proper site for the projected university.
2. A plan for the building thereof.
3. The branches of learning which should be taught therein.
4. The number and description of professorships; and
5. Such general provisions as might properly be enacted by the legislature for the better organizing and governing of the university.

Jefferson, Madison, and Monroe were present at the meeting of the commissioners, and their able and elaborate report to the legislature (indicating much careful thought) had probably been prepared by Jefferson before the meeting was held. This report, recommending, among other things, the site of Central College as the most advantageous one for the university, was forwarded in duplicate to the Speaker of the House and the Speaker of the Senate on August 4, 1818. On January 25, 1819, the legislature adopted a formal act "for establishing an university," and this date must be reckoned as the year of the origin of the university, although the institution was not opened to students until March 7, 1825.

Although Jefferson's was the dominant spirit and the shaping hand in the whole movement for the establishment of a state university, it should be stated that but for the influence and efforts of Joseph Carrington Cabell, the close personal friend of Jefferson, the acts of February 21, 1818, and January 25, 1819, would probably have failed of adoption by the legislature.

The act of January 25, 1819, establishing the university, is as follows:

"1. Be it declared by the General Assembly of Virginia, That the conveyance of the lands and other property appertaining to the Central College in the County of Albemarle, which has been executed by the proctor thereof, under authority of the subscribers and founders, to the president and directors of the literary fund, is hereby accepted, for the use and on the conditions in the said deed of conveyance expressed.

"2. And be it enacted, That there shall be established, on the site provided for the said college, an university, to be called the University of Virginia; that it shall be under the government of seven visitors to be appointed forthwith by the governor, with the advice of council, notifying thereof the persons so appointed, and prescribing to them a day for their first meeting at the said university, with supplementary instructions for procuring a meeting subsequently, in the event of failure at the time first appointed.

"3. The said visitors, or so many of them as, being a majority, shall attend, shall appoint a rector, of their own body, to preside at their meetings, and a secretary to record, attest, and preserve their proceedings, and shall proceed to examine into the state of the property conveyed as aforesaid; shall make an inventory of the same, specifying the items whereof it consists; shall notice the buildings and other improvements already made, and those which are in progress; shall take measures for their completion, and for the addition of such others, from time to time, as may be necessary.

"4. In the said university shall be taught the Latin, Greek, and Hebrew languages; French, Spanish, Italian, German, and Anglo-Saxon; the different branches of mathematics, pure and physical; natural philosophy; the principles of agriculture; chemistry; mineralogy, including geology; botany, zoology; anatomy; medicine; civil government; political economy; the law of nature and nations; municipal law; history; ideology; general grammar; ethics; rhetoric; and belles lettres; which branches of science shall be so distributed, and under so many professors, not exceeding ten, as the visitors shall think proper and expedient.

"5. Each professor shall be allowed the use of the apartments and accommodations provided for him, and those first employed such standing salary as the visitors shall think proper and sufficient, and their successors such standing salary, not exceeding one thousand dollars, as the visitors shall think proper and sufficient, with such tuition fees from each student, as the visitors shall from time to time establish.

"6. The said visitors shall be charged with the erection, preservation, and repair of the buildings, the care of the grounds and appurtenances, and of the interests of the university generally; they shall have no power to appoint a bursar, employ a proctor, and all other necessary agents; to appoint and remove professors, two-thirds of the whole number of visitors voting for the removal; to prescribe their duties and the course of education, in conformity with the law; to establish rules for the government and discipline of the stu-

dents, not contrary to the laws of the land; to regulate tuition fees, and the rent of the dormitories occupied; to prescribe and control the duties and proceedings of all officers, servants, and others, with respect to the buildings, lands, appurtenances, and other property and interests of the university; to draw from the literary funds such monies as are by law charged on it for this institution; and, in general, to direct and do all matters and things which, not being inconsistent with the laws of the land, to them shall seem most expedient for promoting the purposes of said institution; which several functions they shall be free to exercise in the form of by-laws, resolutions, orders, instructions, or otherwise, as they shall deem proper.

"7. They shall have two stated meetings in every year, to-wit, on the first Mondays of April and October; and occasional meetings at such other times as they shall appoint, or on a special call, with such notice as themselves shall prescribe by a general rule, which meetings shall be at the university, a majority of them constituting a quorum for business; and on the death, resignation of a member, or failure to act for the space of one year, or on his removal out of the commonwealth, or by the governor, with the advice of council, the governor with the like advice shall appoint a successor.

"8. The said rector and visitors shall be a body corporate, under the style and title of 'The Rector and Visitors of the University of Virginia,' with the right, as such, to use a common seal; they shall have capacity to plead and be impleaded in all courts of justice, and in all cases interesting to the university, which may be subjects of legal cognizance and jurisdiction; which pleas shall not abate by the termination of their office, but shall stand revived in the name of their successors; and they shall be capable in law, and in trust for the university, of receiving subscriptions and donations, real and personal, as well from bodies corporate or persons associated, as from private individuals.

"9. And the said rector and visitors shall, at all times, conform to such laws as the legislature may, from time to time, think proper to enact for their government; and the said uni-

versity shall in all things, and at all times, be subject to the control of the legislature. And the said rector and visitors of the University of Virginia shall be, and they are hereby, required to make report annually to the president and directors of the literary fund (to be laid before the legislature at the next succeeding session), embracing a full account of the disbursements, the funds on hand, and a general statement of the condition of said university.

"10. The said board of visitors, or a majority thereof, by nomination of the board, shall, once in every year at least, visit the said university; enquire into the proceedings and practices thereat; examine the progress of the students, and give to those who excel in every branch of science there taught, such honorary marks and testimonials of approbation as may encourage and incite to industry and emulation.

"11. On every twenty-ninth day of February, or, if that be Sunday, then on the next, or earliest day thereafter on which a meeting can be effected, the governor and council shall be in session, and shall appoint visitors of the said university, either the same or others at their discretion, to serve until the twenty-ninth day of February next ensuing, duly and timely notifying to them their appointment, and prescribing a day for their first meeting at the university; after which, their meetings, stated and occasional, shall be as hereinbefore provided: *Provided,* that nothing in this act contained shall suspend the proceedings of the visitors of the said Central College of Albemarle; but for the purpose of expediting any objects of said institution, they shall be authorized, under the control of the governor and council, to continue the exercise of their functions, and fulfill those of their successors, until the first actual meeting of their said successors.

"12. And be it further enacted, That the additional sum of twenty thousand dollars shall be, and the same is hereby, appropriated to the education of the poor, out of the revenue of the literary fun, in the aid of the sum heretofore appropriated to that object, and to be paid in the same manner and upon the same conditions in all respects as is prescribed by the

fourth section of the act, entitled 'An act appropriating part of the revenue of the literary fund, and for other purposes, passed the twenty-first day of February, eighteen hundred and eighteen.'

"13. This act shall commence and be in force from and after the passing thereof." (Revised Code, 1819, ch. 34, p. 90.)

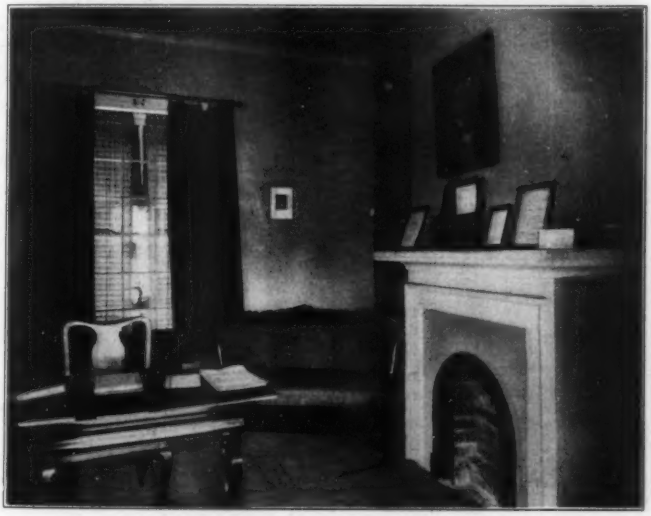
The first board of visitors consisted of four members of the old board of Central College—namely, Thomas Jefferson, James Madison, Joseph Carrington Cabell, and John H. Cocke; the additional appointees were James Breckenridge, Chapman Johnson, and Robert Taylor. The board met for the first time on March 29, 1819, and elected Thomas Jefferson rector. Henceforth, until his death in 1826, Jefferson was the dominating and directing power of the university, not only evolving the entire system of education introduced, but actually devising, to the minutest detail, every feature of construction and administration.

The organization of the university, its government, discipline, and methods of instruction, were virtually prescribed by Jefferson alone; and in many respects they still retain the impression derived from him. By virtue of its charter, the supreme government of the institution, under the general assembly, is vested in the rector and visitors. Under the general direction of this board, and subject to its regulations, the affairs of the university were administered, for the first eighty years of its existence, by the faculty and its chairman, the latter being a member of the faculty, who occupied temporarily the position of chief executive officer of the institution.

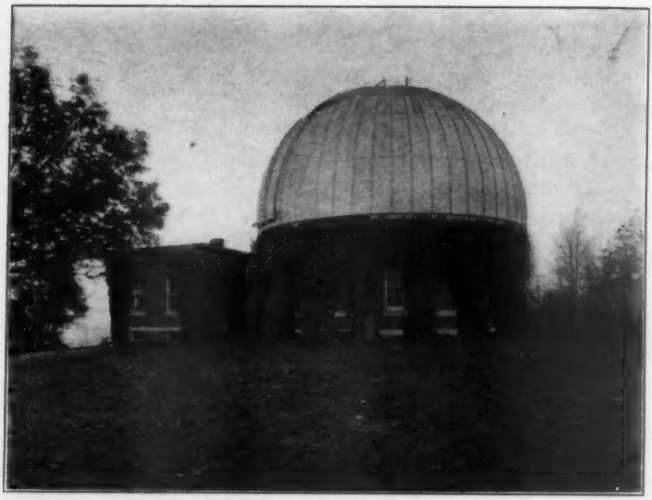
As the university grew, it became more and more difficult for a member of the teaching staff to fill the position of chairman, and attend to the manifold executive duties attached to that office. In October, 1903, the visitors decided that modern conditions rendered necessary the creation of the office of president; and in June, 1904, Edwin Anderson Alderman was elected first president of the University of Virginia.

The scheme of instruction organized by Jefferson contem-

MONTICELLO, THE HOME OF THOMAS JEFFERSON.



THE POE ROOM, 13 WEST RANGE.



THE LEANDER MCCORMICK OBSERVATORY.

THE COLONNADE CLUB, WEST LAWN.

plated no fixed uniform curriculum of studies to be pursued by every student alike, without discrimination. Each distinct branch of knowledge was, as far as was practicable, assigned to an individual "school" with its own instructors; and the university was to consist of a collection of independent schools. The origin of the elective system at the University of Virginia is found in the fact that students were permitted to matriculate in any school or schools of the university for which they were prepared. The wisdom of the founder in establishing such a system has been amply vindicated in the history of this university, and in the adoption by almost all schools of higher education in the country of methods involving this principle.

The original organization embraced eight independent schools—namely, ancient languages, modern languages, mathematics, natural philosophy, moral philosophy, chemistry, medicine, and law. The first seven schools mentioned were opened to matriculates on March 7, 1825, with an aggregate attendance, during the first session, of 123 students. The school of law was not opened until 1826.

This original organization was gradually enlarged and modified. As early as 1837 the school of medicine was elevated to a department, consisting of three individual schools; while in 1850 the school of law was enlarged to a department consisting of two schools. Other departments and schools have been added from time to time. A most notable addition was made in May, 1909, when, through a gift of $500,000 from Mr. Andrew Carnegie to the General Alumni Association, six new schools were established by joint action of the rector and visitors and the alumni board of trustees of the University of Virginia Endowment Fund: The Andrew Carnegie School of Engineering, The James Madison School of Law, The James Monroe School of International Law, The James Wilson School of Political Economy, The Edgar Allan Poe School of English, The Walter Reed School of Pathology.

It was provided by the first board of visitors, in accordance with Jefferson's wishes, that but two degrees should be con-

ferred by the university. The lower degree, characteristic of the institution for many years, was conferred upon a student who had completed all the work offered in any one school; to such a candidate the untitled degree of "graduate" in the school in question should be given. The other, the higher degree, was to be the doctor's degree and was to be given to the graduate in two or more schools who had, in addition, exhibited well-developed powers of research.

There is abundant evidence that, in planning the organization of the University of Virginia, Thomas Jefferson had in mind the so-called continental type of university. The first faculty were, however, with one or two exceptions, Oxford or Cambridge men. Naturally they had in mind the English type of university, and the result was that in 1831 the faculty substituted for the doctor's degree proposed by Jefferson, the master's degree, common in England. The degree of "Master of Arts of the University of Virginia" was accordingly, for more than half a century, the leading degree conferred by this institution.

For eighteen years after the opening of the institution, written examinations were conducted under the surveillance of a committee of three professors. This was not altogether satisfactory, and in June, 1842, Judge Henry St. George Tucker, professor of law, offered the following resolution which the faculty at once adopted:

Resolved, That in all future written examinations for distinction and other honors of the university, each candidate shall attach to the written answers presented by him on such examination a certificate in the following words: "I, A. B., do hereby certify, on honor, that I have derived no assistance during the time of this examination from any source whatever, whether oral, written, or in print, in giving the above answers."

This was the beginning of the honor system at this institution and it has been in operation ever since without interruption. Later the pledge was extended so as to preclude the giving as well as the receiving of assistance. Still more re-

cently the scope of the honor system has been enlarged so as to cover other phases of student conduct. Its administration is entirely in the hands of the students, the essence of the system being that the violation of a student's word of honor is an offense not against the university authorities but against the whole student body, and in the rare occasions on which it has occurred, the students themselves have quietly and promptly sent the offender away from the university without need of faculty action.

Examinations are required to be held in one place and in the presence of the professor in charge of the course or one of his assistants. These regulations in no way conflict with the spirit of the honor system, but are regarded as being necessary to give a proper dignity and formality to the occasion.

Plans are already laid for a fitting observance of the centenary of the incorporation of the University of Virginia, in 1919. Elaborate celebration of that occasion will be made and the history of the growth and development of the institution during this period is one that may well be viewed with pride.

There are several points of particular interest in and about the university which it seems proper to mention specifically for the benefit of those members of the Society for the Promotion of Engineering Education who expect to attend the coming June meeting.

One seldom thinks of the University of Virginia without associating it with its founder, Thomas Jefferson. The home of Jefferson, Monticello, situated about three miles east of the university, Charlottesville lying between, is a mecca for many tourists from all sections of the country. Plans are made for a visit to Monticello during the June meeting. The estate is at present owned by the Hon. Jefferson M. Levy, of New York, who has expended considerable sums on the maintenance and repair of the historic dwelling. In the grounds of Monticello is the burial place of Jefferson, which also will be seen on the trip.

Arrangements have been made for an evening trip to the McCormick Observatory, about one mile southeast of the

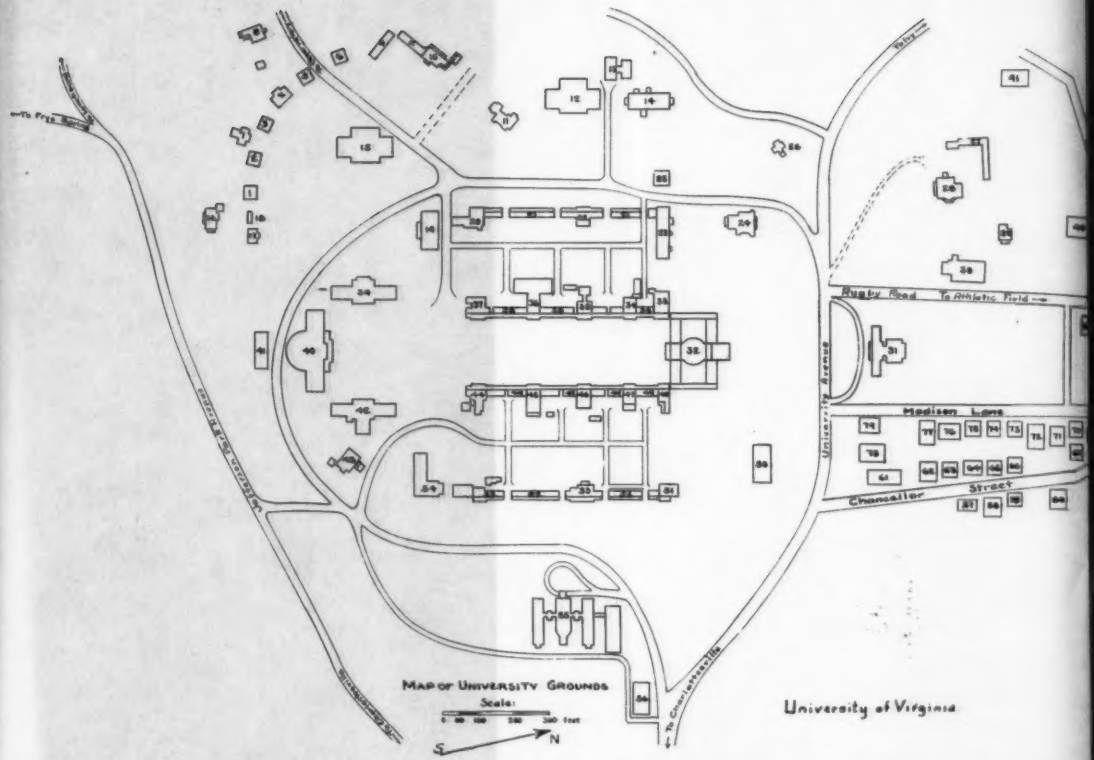
campus on Mount Jefferson. The observatory consists of a forty-five foot dome housing the Clark, twenty-six-inch refractor and many auxiliary astronomical instruments. The building and equipment were made possible through the generosity of Leander McCormick, of Chicago, and later additions were provided by William H. Vanderbilt, of New York. The site of the observatory is a beautiful one with an unobstructed horizon. The present work of the observatory is an extended research on stellar parallax in coöperation with several other world observatories, and a staff of four is busy with the telescope practically every hour that atmospheric conditions allow. An exhibition of the work being done there and an opportunity (weather permitting) for a view of some of the prominent heavenly bodies should make the trip of considerable interest to the delegates.

One of the most prominent literary geniuses of America, Edgar Allan Poe, was a student at Virginia in its earliest days, and his room on West Range has been recently renovated and restored and is now kept unoccupied, but is devoted to the housing of momentos of Poe's presence here. This room will be open for visitors during the meeting.

Especial interest attaches to the Colonnade Club on West Lawn. Housed in the first structure erected on the campus, its main room used by Jefferson as an office during the building of the university and later as the University library, it is a fitting place for the faculty and alumni to meet and preserve the traditions so dear to all men of Virginia. Additions to this building during the past few years have provided quarters for returning alumni and spacious lounge rooms for the club members.

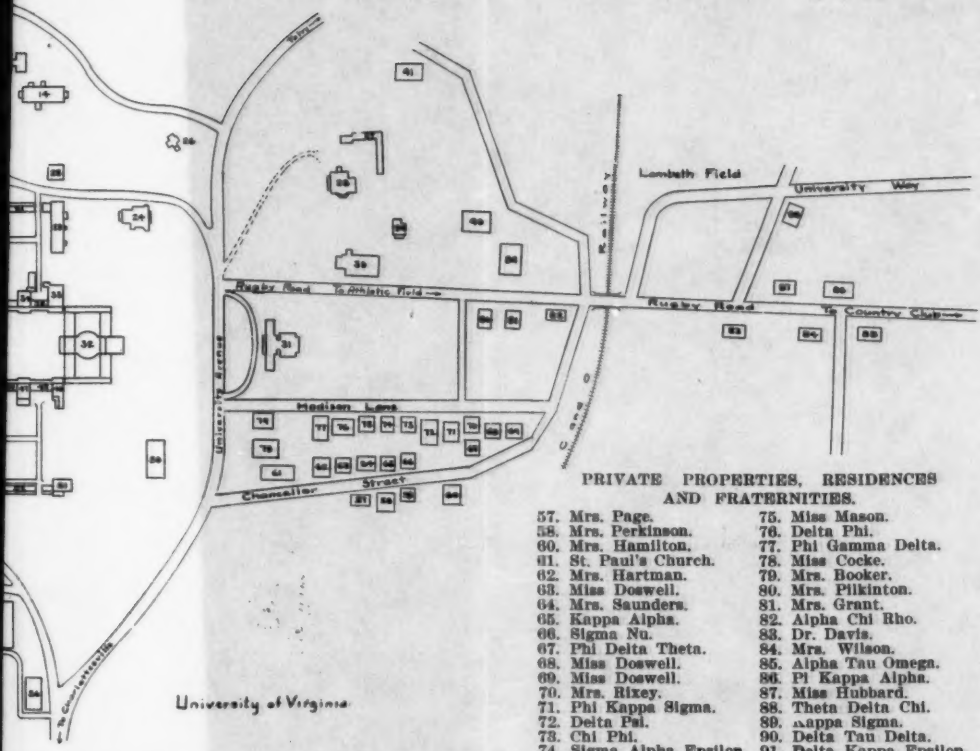
The society will be entertained by the club at a reception during the meeting and the privileges of the club will be extended to the visiting members.

The annual smoker will be held at the Charlottesville Country Club, situated about one and one half miles from the university on a site giving a magnificent view of the surrounding country with the Blue Ridge in the distance.



KEY TO MAP OF UNIVERSITY OF VIRGINIA CAMPUS AND FRATERNI

1, 2, 3, 4, 5, 6, 7. Dawson's Row, Dormitories.
8. Residence, Mr. Moran.
9. Residences, Professors Edgar, Sparrow, Pratt and Mr. Thomas.
10. Residence, Dean Thornton.
11. Residence, Professors Dobie and Goodwin.
12. Peabody Hall, Education Building.
13. Anatomical Laboratory.
14. Analytical Laboratory.
15. Minor Hall, Law Building.
16. Residence, Mrs. Green.
17. Residence.
18. Residence, Professor Bardin.
19. University Commons.
20. Chemical Laboratory.
21. West Range, Dormitories.
22. Jefferson Literary Society Hall.
23. Laboratories of Physiology and Physical Chemistry.
24. Chapel.
25. Histological and Embryological Laboratories.
26. Residence, Professors Newcomb and Lefevre.
28. Residence, President Alderman.
29. Residence, Professor Lambeth.
30. Gymnasium.
31. Madison Hall, University Y. M. C. A.
32. Rotunda.
33. Residence, Board of Visitors.
34. Residence, Professor Minor.
35. Residence, Professor Kent.
36. The Colonnade Club.
37. Residence, Professor Fitz-Hugh
38. West Lawn, Dormitories.
39. Mechanical Laboratory, Building.
40. Cabell Hall, Academic Build Auditorium.
41. Power and Heating Plant.
42. Rouss Physical Laboratory.
43. Nurses' Home.
44. Residence, Dean Lile.



PRIVATE PROPERTIES, RESIDENCES AND FRATERNITIES.

57. Mrs. Page.
58. Mrs. Perkinson.
60. Mrs. Hamilton.
61. St. Paul's Church.
62. Mrs. Hartman.
63. Miss Doswell.
64. Mrs. Saunders.
65. Kappa Alpha.
66. Sigma Nu.
67. Phi Delta Theta.
68. Miss Doswell.
69. Miss Doswell.
70. Mrs. Rixey.
71. Phi Kappa Sigma.
72. Delta Psi.
73. Chi Phi.
74. Sigma Alpha Epsilon.
75. Miss Mason.
76. Delta Phi.
77. Phi Gamma Delta.
78. Miss Cocke.
79. Mrs. Booker.
80. Mrs. Pilkinton.
81. Mrs. Grant.
82. Alpha Chi Rho.
83. Dr. Davis.
84. Mrs. Wilson.
85. Alpha Tau Omega.
86. Pi Kappa Alpha.
87. Miss Hubbard.
88. Theta Delta Chi.
89. Kappa Sigma.
90. Delta Tau Delta.
91. Delta Kappa Epsilon.

UNIVERSITY OF VIRGINIA CAMPUS AND FRATERNITIES.

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Society Hall.
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Embryological Labora-

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or Lambeth.

versity Y. M. C. A.

32. Rotunda.
33. Residence, Board of Visitors.
34. Residence, Professor Minor.
35. Residence, Professor Kent.
36. The Colonnade Club.
37. Residence, Professor Fitz-Hugh.
38. West Lawn, Dormitories.
39. Mechanical Laboratory, Engineering Building.
40. Cabell Hall, Academic Building and Auditorium.
41. Power and Heating Plant.
42. Rouss Physical Laboratory.
43. Nurses' Home.
44. Residence, Dean Lile.
45. Residence, Professor Echols.
46. Residence, Professor Graves.
47. Administration Offices.
48. Residence, Professor Smith.
49. East Lawn, Dormitories.
50. Brooks Museum, Geological Laboratory.
51. Washington Literary Society Hall.
52. East Range, Dormitories.
53. Residence, Reverend B. D. Tucker.
54. Randall Building, Dormitories.
55. Hospital.
56. Entrance Building, Postoffice, Express Office, Tea Room.

Surrounding the university in the countryside are many beautiful homes, and an opportunity will be given the ladies of the party to see much of this section and also a most charming outlook from the top of a nearby peak of the Blue Ridge.

Various other lesser points of interest around the university will serve to take up the time of the visitors to its fullest extent, and if the projected trip through the historic James River section materializes as planned, the society should have obtained a rather complete idea of this most attractive section of our commonwealth.

PRELIMINARY REPORT OF COMMITTEE NO. 7, INSTITUTIONAL.

COMMITTEE.

G. R. CHATBURN, *Chairman*, Univ. of Nebraska, Lincoln, Nebr.
MARTIN MCCUE, Univ. of Notre Dame, Notre Dame, Ind.
F. H. CONSTANT, Princeton Univ., Princeton, N. J.
C. H. CROUCH, Univ. of North Dakota, Grand Forks, N. D.
HOLLIS GODFREY, Drexel Inst., Philadelphia, Pa.
H. L. HODGKINS, George Washington Univ., Washington, D. C.
F. E. AYERS, Univ. of Akron, Akron, O.
IRA N. HOLLIS, Worcester Poly. Inst., Worcester, Mass.
C. L. CRANDALL, Cornell Univ., Ithaca, N. Y.
F. E. TURNEAURE, Univ. of Wisconsin, Madison, Wis.
J. B. HILL,
A. A. POTTER, Kansas State Agri. Coll., Manhattan, Kans.
C. L. CORY, Univ. of Calif., Berkeley, Calif.
H. N. LENDALL, Rutgers College, New Brunswick, N. J.
J. F. MERRILL, Univ. of Utah, Salt Lake City, Utah.
S. B. MCCORMICK, Univ. of Pittsburgh, Pittsburgh, Pa.
S. W. BEYER, Iowa State College, Ames, Ia.
P. F. WALKER, Univ. of Kansas, Lawrence, Kans.
W. S. RODMAN, Univ. of Virginia, University, Va.
J. F. WILSON, Univ. of Michigan, Ann Arbor, Mich.
C. E. MAGNUSSON, Univ. of Washington, Seattle, Wash.
G. M. BRAUNE, Univ. of Cincinnati, Cincinnati, O.

REPORT.

During the year there have been sent to the several members of the committee and to others two circular letters, copies of which are herewith submitted. These letters fully explain themselves and the nature of the work undertaken. In connection with the answers to these letters considerable other correspondence has been necessary. As a result of this correspondence the following tentative reports have been outlined by the chairman as the basis for discussion and final action by the committee at the Virginia meeting.

PRELIMINARY REPORT OF COMMITTEE NO. 7.

LINCOLN, NEBR., December 28, 1915.

TO THE MEMBERS OF THE INSTITUTIONAL COMMITTEE:

President Hollis Godfrey, a member of this committee, suggests that a meeting of the committee be held at Drexel Institute the first week in February for the purpose of discussing matters of importance to the committee and arranging a program for the next annual meeting of the Society. President Godfrey invites us to be his guests while in Philadelphia. What do the members think of this?

Secretary Bishop puts up to the committee a peculiar situation and asks for a definition of policy. A regular member of the Society represents his institution as a duly appointed delegate. He now claims, therefore, exemption of dues. In order to settle this matter and that proper legislation may ensue, it appears to your chairman that the committee should recommend definite answers to the following questions:

1. May institutional delegates be non-members of the Society?
2. If so, shall their names be published in the membership list in the year book?
3. Or, should they be published in a separate list (perhaps with the names of the institutions represented)?
4. Shall they, individually, receive the publications of the Society?
5. Should the Society require non-member delegates to pay dues?
6. Shall members who also act as institutional delegates be relieved from paying dues during the time of such delegateship?
7. If dues are not paid will the delegate lose his membership in the Society and have to petition for reinstatement?

In addition to acting on the above, information on the following questions might be collected by the committee:

1. What is the practice of engineering schools regarding advanced credit for work done in other schools?
2. Can a just and equitable method for grading such credit be devised?

3. What percentage of institutions pay the whole or part, and what part, of the expenses of the institutional delegate to the annual meeting of the Society?

The chairman would be pleased to have by return mail from each member of the committee, and any others who may be interested, comments on these matters: First, a meeting of the institutional committee at Drexel Institute; second, the status of institutional delegates per se; third, the remaining questions submitted; and fourth, any other questions deemed appropriate for submission to the committee or which will assist in preparing a program for the next annual meeting.

Wishing you all the compliments of the season, I remain,

Very truly yours,

GEORGE R. CHATBURN,
Chairman, Institutional Committee.

LINCOLN, NEBR., February 3, 1916.

TO THE MEMBERS OF THE INSTITUTIONAL COMMITTEE:

Fifteen members of the Committee and President Jacoby have responded to my circular letter of December 28. Of these sixteen, nine express themselves as favoring or not opposed to a meeting of the committee in Philadelphia; three oppose such a meeting and only three of those favoring say they can attend, one more "may be able to," seven can not, and five are non-committal. Under the circumstances, I think this hardly warrants calling a special meeting before the regular session of the Society.

Below is a synopsis of the returns on the second matter submitted:

1. May institutional delegates be non-members of the Society? Yes, eight votes; no, seven; not voting, one.

2. If so, shall their names be published in the membership list in the year book? No, eleven votes; not voting, five. It is but just to say that most of those not voting on this and following questions voted "no" on the first question; this, they thought, made it unnecessary to vote on the remainder.

3. Or, should they be published in a separate list (perhaps

with the names of the institutions represented)? Yes, ten votes; no, one; not voting, four.

4. Shall they, individually, receive the publications of the Society? No, eleven votes; not voting, five.

5. Should the Society require non-member delegates to pay dues? No, ten votes; not voting, six.

6. Shall members who also act as institutional delegates be relieved from paying dues during such delegateship? No, fifteen votes; not voting, one.

7. If the dues are not paid will the delegate lose his membership in the Society and have to petition for reinstatement? Generally of the opinion that no special privileges be accorded to institutional delegates in this respect.

As a basis for discussion may I present the following:

1. While no restrictions are laid upon institutions holding membership in this Society, each is requested to appoint a delegate to the annual meeting, if practicable, from those persons in the faculty who are members of this Society, or, from its administrative staff. (See page 27, 1915 *Proceedings*).

2. The names of institutional delegates shall be published in connection with the names of the institutions.

3. Institutions receive the publications of the Society, the delegates as such do not.

4. Non-member delegates are not required to pay dues; the institutions, of course, do.

5. Regular members who act as institutional delegates are not thereby relieved from the payment of dues.

I would like to place before you a suggested change in the personnel of this committee. The rule adopted last year reads, "The delegates in attendance at any meeting shall continue as members of the committee for one year. . . ." (Page 27, 1915 *Proceedings*.) The suggested change is to insert after "delegates" the restrictive clause "who are members of the Society."

Professor Constant wishes to add one more question: "Should the institutional dues be reduced to be the same as

that required of regular members?" At present the institutional dues are $10 per annum; this includes three sets of publications.

A few members submitted suggestions for the program at the annual meeting. Thanks. Others will be gladly received. Likewise, there seems to be some unfinished business "wished upon us" from the last meeting. (See page 28 of the 1915 *Proceedings*.) I respectfully ask all members to re-read the matter pertaining to this committee in that volume, pages 13 to 32 inclusive. As soon as possible, but not later than March 1, please send to me, concisely and clearly stated, your ideas of what should be published as the duties of the institutional delegate. This is in compliance with the action of the committee as shown by the *Proceedings*.

Kindly send in any ideas or suggestions that may occur to you as of interest to this committee or helpful to the program of the meeting next June. I will compile all matters received, and will either send a synopsis out to you or have it ready when we meet. Very truly yours,

GEORGE R. CHATBURN,
Chairman, Institutional Committee.

POLICY OF THE SOCIETY REGARDING INSTITUTIONAL DELEGATES.

The Institutional Committee respectfully recommends that the following be adopted as the policy of the Society:

1. At least six weeks prior to the annual meeting the Secretary will send to each institution holding membership a request for the appointment of a delegate, if practicable, from the persons of the faculty who are members of this Society, or, from its administrative staff.

2. The names of institutional delegates will be published in the Year Book in connection with the names of the institutions.

3. Three copies of the publications of the Society will be sent to the institution, and not to the delegate.

4. Non-member delegates will not be required to pay dues.

5. Regular members who act as institutional delegates are not thereby relieved from the payment of dues.

PERSONNEL OF THE COMMITTEE.

The Institutional Committee further recommends that the rule adopted last year (page 27, 1915 *Proceedings*) namely: "The delegates in attendance at any meeting shall continue as members of the committee for one year thereafter or until their successors have been appointed by the heads of their respective institutions," be amended by inserting after "delegates" the restrictive clause, "who are members of the Society."

THE PURPOSES OF INSTITUTIONAL MEMBERSHIP.

The Institutional Committee further recommends that the following be adopted as a statement of the purposes of institutional membership:

That the results of the Society might be brought more directly to the attention of the teachers and administrative officers.

That the institutions might be brought to look upon the Society as their servant in matters affecting general educational welfare.

That the publications of the Society might be freely distributed to college libraries and administrative officers.

That the Society might have an agency for duly considering special problems of engineering education and college administration closely relating to the institutions themselves.

THE DUTIES OF THE INSTITUTIONAL DELEGATE.

The Institutional Committee further recommends that the following be adopted as a statement of the duties of the institutional delegate:

Before the Annual Meeting.

To familiarize himself with the needs and desires of his own institution.

To familiarize himself with new methods and practices in his own institution.

To have these prepared for presentation to this Society.

To bring before his own faculty, and especially the local members of the Society, questions of policy and interest to the general Society.

During the Annual Meeting.

To observe carefully the program and take note of those reports, papers and discussions of interest to his own institution.

To attend the meetings of institutional delegates.

To present to the Society pertinent ideas and practices of members of his own faculty.

To ascertain through conversation and otherwise the practices of other institutions regarding questions under discussion during the year in his own.

To extend his acquaintanceship and note especially the personality of men available for positions in his own institution.

To represent generally his own institution as an attorney by looking after its interests whatever they may be and whenever and wherever deemed necessary.

After the Annual Meeting.

To make a brief report to the administration of his institution, touching in a general manner the most salient features of the convention.

To make at the opening of the fall term a more detailed report to his engineering faculty at a meeting called for that purpose.

To represent during the school year following the annual meeting the general Society in his own institution.

To furnish news items, or procure someone else to furnish them, to the BULLETIN.

To bring the general Society as fully as possible before the faculty of his institution.

To encourage members to attend the annual meeting by bringing back to them its enthusiasm and showing them the

advantages, both to themselves and the institution, of attendance.

Respectfully submitted for the Institutional Committee,

GEORGE R. CHATBURN,
Chairman.

PRELIMINARY REPORT OF COMMITTEE NO. 8, ENTRANCE REQUIREMENTS.

COMMITTEE.

J. J. FLATHER, *Chairman*, Univ. of Minnesota, Minneapolis, Minn.
L. P. BRECKENRIDGE, Yale Univ., New Haven, Conn.,
H. E. WEBB, Central M. T. H. S., Newark, N. J.,
C. M. WIRICK, Junior College, Crane Tech. H. S., Chicago, Ill.
F. N. MCNAIR, Mich. Coll. of Mines, Houghton, Mich.

Editor's Note.—The following questionnaire was sent out by this committee. The replies will be used as the basis of a report which will be presented at the Virginia meeting.

QUESTIONNAIRE.

1. What changes, if any, have been made in the entrance requirements to your institution since the 1910 report was submitted to the Society for the Promotion of Engineering Education?
2. What suggestions, if any, have you to make regarding entrance requirements?

PRELIMINARY REPORT OF COMMITTEE NO. 9, ADMINISTRATION.

COMMITTEE.

F. H. CONSTANT, *Chairman*, Princeton Univ., Princeton, N. J.,
W. M. RIGGS, Clemson College, Clemson College, S. C.,
O. V. P. STOUT, Univ. of Nebraska, Lincoln, Nebr.,
R. W. GAY, Miss. A. & M. College, Agricultural College, Miss.
A. H. FULLER, Univ. of Washington, Seattle, Wash.,
J. P. JACKSON, Dept. of Labor, Harrisburg, Pa.,
FRED. BASS, Univ. of Minn., Minneapolis, Minn.

Editor's Note.—The following questionnaire was sent out by this Committee. The replies will be used as a basis of the report which will be presented at the Virginia meeting.

QUESTIONNAIRE.

1. Give the number of weeks covered by your summer vacations and the percentage of time which you have devoted during the past five summers to employment, classified generally as follows:
   - *A.* Teaching.
   - *B.* Study.
   - *C.* Preparation for work of following session.
   - *D.* Research.
   - *E.* Literary.
   - *F.* Professional work in line with teaching.
   - *G.* Work along other lines.
   - *H.* Rest and recreation.
   - *I.* Not classified above.
2. Give the percentage of time which you have devoted during the past five years (exclusive of the summer vacations), to work not connected with the college and the character of such work, classifying it generally as follows:
   - *D.* Research.
   - *E.* Literary.
   - *F.* Professional work in line with teaching.
   - *G.* Work along other lines.
   - *I.* Not classified above.
   - (*a*) Which of the above work, classified in both 1 and 2, was continuous throughout the year?
   - (*b*) Were you, at any time, during the period under consideration, relieved of any part of your regular college work in order to be given time for outside work? If so, when and how much?
3. Which of the work scheduled in 1 and 2 was done primarily to obtain income?

   Which to obtain experience?

(*a*) To improve your work in teaching?

(*b*) To increase your capacity as an engineer?

4. State how your outside work has reacted upon your regular college teaching work.

(*a*) What part of it do you consider to be of greatest value in your teaching work?

(*b*) What part do you consider of least value?

5. What are the opportunities for outside professional employment open to you in your field (give a detailed list of positions or jobs)?

(*a*) During the summer?

(*b*) Throughout the entire year along with your regular college duties?

(*c*) What difficulties do you encounter in getting professional employment?

(*d*) How does the income from such employment compare with your regular salary?

(*e*) Have you time or strength for outside employment during the college year in addition to your full college work?

6. Do you consider it advisable for engineering teachers to engage in outside professional work during the summer? Give reasons for and against.

7. Do you consider it advisable for engineering teachers to engage in outside work during the year? Give reasons for and against.

(*a*) What limitations upon the character of such work are desirable?

(*b*) What limitations upon the amount of such work are desirable?

8. What summer employment will be of greatest benefit to the following classes of teachers, viewed from (*a*) the teacher's standpoint; (*b*) the student's standpoint?

A. Teachers of pure science, including mathematics, mechanics, drawing, etc.?

B. Teachers of applied science, such as hydraulics,

strength of materials, material testing, hydraulic or steam engine laboratories, stresses, kinematics, etc.?

C. Teachers of professional subjects, such as water supply engineering, bridge design, sanitary design, etc.?

9. What fields should be refused, if offered?
10. Is it desirable that engineering teachers be employed by the college upon a part-time basis in order that they may devote more time to outside practice? How would this react upon
    (*a*) The college?
    (*b*) The student?
11. What do you think of a plan of reserving outside work for occasional periods of one or two years at a time upon leave of absence from college work?
12. In what way can the teacher's outside work be made valuable to his students?
13. Does an engineering teacher in good health need rest during the summer, or will a change of occupation and surroundings answer the same purpose?

Questions 1 to 4 are statistical. The Committee wishes to find out the amount and character of work actually being done by engineering teachers and to classify it in some general way. It is hoped the members will search their memories and give as complete detailed data as possible covering their own lives in the recent past. In case the last five years are not representative of the member's normal life, a longer period may be taken, but that fact should be stated. Question (1) covers summer employment only, but it is believed that the whole question is intimately tied up with that of outside work throughout the year. Accordingly, question (2) covers outside employment during the college months. (1) and (2) together, therefore, include the entire year. Special care will be needed to answer (4) without a natural personal bias.

There will be a tendency to answer it off-hand and in the affirmative, whereas much outside work may be of little or no value either directly or indirectly for the students. When the work absorbs too large a portion of the instructor's time or is

merely of a pot-boiling character, where it tends to narrow his interests and breadth of view, or to decrease his stock of vitality, it may react negatively upon his teaching work. It is hoped that the answers to (5) will throw some light upon the opportunities actually open to engineering teachers for outside employment and bring out the difficulties which they encounter in getting such employment, especially for the restricted summer vacations. To be of value, actual lists of the kinds of positions or jobs which would in all probability be open to the member should be given. The remaining questions seek to bring out the member's views in regard to employment and his personal recommendation of the fields in which instructors may most advantageously engage, as well as the manner in which this outside work may be made of greatest value in their teaching.

The replies to the questionnaire will be regarded as confidential by the Committee, and personal signatures are not essential. Please state college title and the special field of your work, thus Assistant Professor of Electrical Engineering in a State University; Professor in Civil Engineering in an Eastern College (special field, sanitary engineering), etc.

PRELIMINARY REPORT OF COMMITTEE NO. 10, MATHEMATICS.

COMMITTEE.

L. C. PLANT, *Chairman*, Mich. Agri. College, East Lansing, Mich.,
E. V. HUNTINGTON, Harvard University, Cambridge, Mass.,
H. E. COBB, Lewis Institute, Chicago, Ill.,
E. R. HEDRICK, University of Missouri, Columbia, Mo.,
S. A. MOSS, General Electric Co., Lynn, Mass.

QUESTIONNAIRE.

The following questions were sent to heads of departments of mathematics, physics, and mechanics:

1. Does your department keep informed on the work given by the other above-mentioned departments?

(*a*) By meeting with these departments for discussion?

(*b*) By becoming conversant, through acquaintance with texts or lecture notes, with the subject matter offered by these departments?

2. By what means and to what extent do you endeavor

(*a*) To prepare your students for the particular work to follow?

(*b*) To base your course on the foundations laid by the courses which precede?

3. When selecting your faculty do you take into consideration their preparation, ability and tastes in the other subjects mentioned as well as in the subject they will teach?

4. Will you state in what ways coördination in these subjects may prove helpful?

REPORT.

One hundred and four replies to the above questions have been received to date. In different institutions mathematics and physics, physics and mechanics, or mathematics and mechanics are under one head. These replies, therefore, in many cases include information concerning more than one subject.

Twenty-five per cent. of the replies to question 1-*a* are in the affirmative, while fifty-five per cent. say the department keeps informed on the work given by the other mentioned departments indirectly by frequent informal discussions with heads and instructors of the other departments.

Seventy-five per cent. of the replies to question 1-*b* state that the department keeps informed in a general way on the subject matter offered by the other departments.

Fifty-eight per cent. of the replies to question 2-*a* state that some effort is made to prepare students for the particular work to follow. The following typical replies will give some idea as to the means used:

"We endeavor to prepare our students for the particular work to follow by means of special lectures as well as informal discussions."

"We endeavor to prepare our students for the particular work to follow, first, by borrowing illustrations for lecture and laboratory work from subjects ahead; second, by emphasizing whenever possible the application of present processes to future work; third, by encouraging proper collateral reading."

"We devote a good deal of time to fundamentals, and then give a great many problems taken from mechanics and from engineering texts. This requires a small amount of extra explanation."

"The heads of the various departments submit outlines of work required to meet their needs, and the course in physics is adapted to these in so far as possible."

"One recitation each week is devoted to problems, which have particular bearing upon engineering topics. For example, we devote especial attention to the relation of practical units to absolute units, measurements of mechanics, heat, and electricity. We have an understanding with the members of the engineering faculty that certain subjects in physics will be emphasized, and other subjects touched upon lightly, depending upon the nature of the course which is to follow."

"The teaching staff (in mechanics) includes graduates in civil engineering, mechanical engineering, and electrical engineering. Thus the staff is fairly well informed on the nature of the work to follow. By inquiring we get still other information about subsequent work and we aim to make our courses cover subsequent needs. I estimate that fifty per cent. of our instruction is based on subsequent needs (in college)."

Forty per cent. of the replies to question 2-*b* state that either through acquaintance with texts used in preceding courses or by interchange of instructors they are fairly well acquainted with the particular preparation of their students.

Sixty per cent. of the replies to question 3 say ideally, yes, but in practice it is difficult to find the man who can qualify or to find the money with which to get the man.

Question 4, "Will you state in what ways coördination in these subjects may prove helpful?" received such a vigorous

response that it seems wise to quote at some length from these replies. The following quotations are taken about equally from departments of mathematics, mechanics, and physics:

"Answering somewhat in the negative we would say that we do not see how instruction can be effective without some coördination."

"The instructors in each department should know just what the students had had in the other departments and not accept 'never heard of it before' as an excuse from students."

"Each should be reasonably familiar with the work of the allied departments. This is just as true of the engineering department as of the mathematics department. One trouble is that the 'engineer's math' is not up to date, and the same is true, perhaps, of the mathematician's applications."

"Coördination would avoid the unsatisfactory results brought on by a disjointed course. It would secure the proper repetition of those facts and principles which are fundamental, and which must be repeated a number of times before a proper understanding is attained. Proper repetition is a keynote in education."

"By coördination repetition is avoided, and thus time is saved for a more thorough consideration of the subject taught."

"Each department should make its own work dovetail into the work of the other departments in such a way that the students are led to see that the relation existing between them is very close. The teacher in mathematics should keep constantly in mind the fact that his work is to become a useful tool in the hands of his students for dealing with future difficulties."

"I find the greatest need for coördination in problem work. Much time can be saved and better results obtained when the problems are so stated and so discussed in the three departments mentioned above that the students realize the intimate relations between these subjects. The theoretical discussions in these departments will necessarily be from somewhat different points of view."

"Teachers in earlier subjects would know more clearly what particular points should be drilled on for benefit of following courses. Teachers in later courses would know more clearly what preparation to count on. Some unnecessary duplication would be avoided."

"I believe that formal conferences between the faculties of mathematics, physics, and mechanics would prove very beneficial in coördinating the work of these departments, provided, of course, these conferences were entered into in the *right spirit and with a determination to fully coöperate.*"

In a few institutions an engineering council, composed of the heads of departments, has charge of courses of study and hence the sequence of studies. This council in some cases looks after coördination in a limited way.

PRELIMINARY REPORT OF COMMITTEE NO. 11, PHYSICS.

COMMITTEE.

D. C. MILLER, *Chairman*, Case School of Applied Science, Cleveland, Ohio,
W. S. FRANKLIN, Columbia University, New York, N. Y.,
G. A. GOODENOUGH, University of Illinois, Urbana, Ill.
F. K. RICHTMYER, Cornell Univ., Ithaca, N. Y.,
R. M. BIRD, Univ. of Virginia, University, Va.,
J. H. JAMES, Carnegie Inst. of Tech., Pittsburgh, Pa.,
H. P. TALBOT, Mass. Inst. of Tech., Boston, Mass.

Editor's Note.—The following questionnaires were sent out by this Committee. The replies will be used as a basis of the report which will be presented at the Virginia meeting.

QUESTIONNAIRE A.

(Sent to teachers of physics.)

1. What are the entrance requirements for physics and for mathematics in your institution?
2. (*a*) What is the minimum time given to instruction in physics by lectures, by recitation, and by laboratory practice?

(*b*) In what year or years does this work fall?

(*c*) In the light of your experience, do you recommend a different arrangement of schedule?

3. Do those who have had preparatory physics take courses different from those who have not? Does preparatory physics materially advance the student's progress?
4. How is the time given to general physics divided between the various sections of the subject?
5. In case your institution has an academic department is physics (for engineering students) taught in it or in the engineering department?
6. What steps are taken to secure continuity of subject matter between physics and the several subsequent engineering subjects for which physics is supposedly a prerequisite?

QUESTIONNAIRE B.

(Sent to teachers of physics and engineering.)

1. Should instruction in general physics include such subjects as dimensional equations, black body radiation, radioactivity, X-rays, etc.?
2. Do your students in engineering take, in addition to the regular prescribed courses, advanced elective courses in physics? What is the attitude of the engineering faculty in this matter?
3. Should calculus be required as a prerequisite for the general physics courses, and should calculus methods be used in the instruction in physics?
4. Should different courses in physics be given to different groups of engineers, as architects, electrical engineers, etc.?

QUESTIONNAIRE C.

(Sent to practicing engineers.)

1. What are the criticisms of the teaching of physics, as observed by you?

2. Do you think the amount of laboratory work, as usually given, is sufficient?
3. Should the calculus methods be used in general physics courses?
4. Are the mathematical or theoretical aspects of physics of value to the engineer?
5. In the light of your experience, what changes would you think desirable in the education of the engineer as to:
   (*a*) Time spent in studying fundamental sciences in comparison with time spent in studying the technology of engineering.
   (*b*) Method of presenting work in physics.
   (*c*) Subject matter taught in physics.
   (*d*) Any other items relating to this general subject.

PRELIMINARY REPORT OF COMMITTEE NO. 12, ENGLISH.

COMMITTEE.

SAMUEL C. EARLE, *Chairman*, Tufts College, Tufts College, Mass.
F. N. RAYMOND, University of Kansas, Lawrence, Kans.
J. M. TELLEEN, Case School of Applied Science, Cleveland, O.
C. F. PARK, Massachusetts Institute of Technology, Boston, Mass.
FRANK AYDELOTTE, Massachusetts Institute of Technology, Boston, Mass.
C. W. PARK, University of Cincinnati, Cincinnati, O.

QUESTIONNAIRE.

Dear Sir: Committee No. 12, English, of the Society for the Promotion of Engineering Education has been instructed by the Society to present a report on the "present status of the teaching of English to engineering students." To assist the Committee in gathering the necessary data, will you kindly have the following questions answered for your institution (as far as the students of engineering are concerned) and returned *as soon as possible* to S. C. Earle, chairman, Tufts College, Mass.?

In order to get light on the subject from different angles, the Committee asks to have one set of questions answered for

the Department of English and a duplicate set answered by one who can speak for those not teachers of English. The Committee asks that the answers be brief (categorical where possible) but that special effort be made to present specifically whatever there may be in the practice of the institution that would be of interest to others, and whatever defects the one answering finds in present practice.

It should be borne in mind that in the report of the Committee the names of the institutions furnishing data will not appear. The purpose of the inquiry is not at all to criticize or even to compare institutions as such; it is to study the present general status for the benefit of all concerned.

Name of Institution Reporting .....Address.....

Topic No. 1.—In what sense is English a "fundamental" subject in the education of engineers? (The S. P. E. E. has included English in its list of "fundamental" subjects.)

I. In your course for students of engineering is English "fundamental" in theory and in practice? (The following questions may suggest ways in which answers can be made specific. Is English given the same weight in promotion as such subjects as mathematics or physics? Is the importance of good English stressed by the various members of the faculty in their class work? What preparation is required of teachers of English? What is their standing as members of the faculty?)

II. On what grounds is composition justified as a "fundamental" subject in your institution? (Suggestions: On the ground that it teaches "typist" English: spelling, capitalization, punctuation, syntax? "Business" English: letter writing? "Engineering" English: technical reports? Other forms of composition; "literary" composition, specifically adapted for engineering students or not? Style? Accuracy of thinking? Imagination?)

III. On what ground is the study of literature justified?

(Suggestions: Development of understanding of literary history? Of appreciation of style? Of understanding of subject-matter?)

Topic No. 2.—What opportunities are offered for the study of English?

I. Required work? (Suggestions: Is the English instruction specially "adapted" to students of engineering? If so, on what ground, to what end?)

II. Electives? (Suggestions: What opportunities are offered for instruction in English in addition to the required courses? How generally do your students take advantage of such opportunities?)

III. Coöperation of departments? (Suggestions: Do students of engineering receive training in composition in any courses other than those given by teachers of English? In what ways, if any, do the teachers of English and of other subjects coöperate in training students in the use of English? Are any courses required or offered for election that are considered as collateral to the study of English literature?)

Topic No. 3.—What methods of instruction are in practice in your institution? (Those not teachers of English may state what methods they believe should be in practice.)

(Suggestions: Lectures or discussions? Class work or conferences—how many personal conferences does each student have and to what extent does the instructor discuss papers with the writers? Does the study of theory—rhetoric—or of literary or technical models precede or follow the experiments of the students in writing? Does the instructor seek subjects for composition in the interests and occupations of the students, or does he assign subjects in regard to which he wants to develop their interest? Is their instruction in grammar or only correction of errors? Is instruction given in the form of dogmatic rules or of general principles? Is there systematic correla-

tion of the work in English with that in modern languages?) Please submit a synopsis or calendar of the required work in English, showing (*a*) the succession of topics, (*b*) the number of themes required, (*c*) the texts used, (*d*) the reading required.

Topic No. 4.—What are the aims and the results of your instruction in English?

I. Does your school train men chiefly for any special grade of engineering work? (Shop or drafting-room assistant, superintendent, consulting engineer, etc.)

II. What do you consider the ultimate purpose of instruction in English?

Suggestions: To meet the technical needs that arise in engineering work? To give something of the general education one must have to succeed as an engineer? To give anything in the way of general education that transcends the professional needs of an engineer?

III. Does the English department make any effort to obtain an opinion of the student's ability to write that is free from the bias of the English instructor?

IV. What is the judgment of the instructors who have charge of the more advanced technical work of the students as to the results of the instructor in English?

Signed, ...

The Committee expects to be able to make a report that will be of interest and of practical service; but to do so this must have the hearty and sympathetic coöperation of all to whom it makes appeal for data. Will you not give us the benefit of your experience in every way you can, and thus assist us in the interest of engineering education?

Yours truly,

SAMUEL C. EARLE, Tufts College, Mass., *Chairman*,
F. N. RAYMOND, Univ. of Kansas,
J. M. TELLEEN, Case School of Applied Science,
C. F. PARK, Mass. Inst. of Tech.,
FRANK AYDELOTTE, Mass. Inst. of Tech.

PRELIMINARY REPORT OF COMMITTEE NO. 12.

REPORT.

Committee No. 12, English, appointed at the Ames Meeting of the S. P. E. E., June, 1915, was instructed to give its attention for the year to the "present status of the teaching of English to engineering students," and to that end was asked to prepare a questionnaire to be sent from the Secretary's office to the various schools on the Society's list. The questionnaire follows:

The Questionnaire.—There was strong objection, on the part of members of the Committee, to the circular method of obtaining data, not only because of its well-known liability to seem to justify conclusions that do not represent real conditions, but because teachers of all subjects are at present being seriously discommoded by the stand-and-deliver attacks of the questionnaire. Nevertheless, inasmuch as this year's work must at best be merely preliminary, the Committee felt that after all this was, for certain reasons, the best method of approach. The very fact that the receiver's first impulse is to slip a questionnaire into the wastebasket unread protects the inquirer from many who would contribute nothing more valuable than such data as is obtainable from catalogues. The Committee hoped that those teachers who have developed methods in which they have strong personal faith and those who find themselves hampered by the conditions under which they have to carry on their work would welcome the chance to share their success or to appeal for assistance in their discouragement, even if no better opportunity was offered than that of answering circular questions. Furthermore, although personal visits to even a few schools would give more trustworthy data and clearer insight, circulization makes it possible to get into equal connection with every school, thus avoiding any bias members of the Committee might have as to which schools are most worth studying. It has been the intention of this Committee carefully to avoid the assumption that all real progress, all best methods are to be found in the North or the East, in the largest institutions or in those of longest standing;

to recognize, in other words, that good things may come even out of Nazareth.

The result of the Committee's efforts to draw up a list of questions varied enough in form to catch as many ideas as possible was sent out from the Secretary's office early in January. Some fifty questions were grouped under four general topics:

1. In what sense is English a "fundamental" study in the education of engineers?
2. What opportunities are offered for the study of English?
3. What methods of instruction are in practice in your institution?
4. What are the aims and the results of your instruction in English?

Each member of the Committee chose a share of the questions to which he is giving special attention; but, on account of the slowness with which the replies have come in, nothing can be reported at present other than a general impression and that the chairman has had to write without consulting with the other members. The tabulated results together with the conclusions of the Committee as a whole will be published at an early date. Even the little here presented, however, would seem to indicate how much there is in the subject for discussion and reflection.

A General Impression as to the Present Status.

1. A large percentage of the replies thus far received are extremely *general and vague*. Many of the teachers of English make definite statements as to routine, but seem not to have seriously attempted to define the larger problems of purpose and method of organization. The answers of those not teachers of English are often more definite, but they incline either to be narrow or to pay insufficient attention to the difficulties of accomplishing the ends they advocate. Some of the teachers of technical subjects are, in the opinion of their fellow teachers of English, "poor judges of English"; some expect much of the English department but are unwilling to

grant it sufficient time or coöperating sympathy and support; on the other hand, some "are among the best forces for English."

2. As to whether it is the English teacher's business *to teach English* or *to teach engineers*, there seems to be much difference of opinion, often vaguely implied rather than definitely stated. Not only those who teach English in an engineering school because they have not obtained "a better position," but some of the best teachers of English who have to give instruction to engineers along with their "regular" students, are firmly convinced that "English" is a subject that offers broad educational possibilities of value to all alike and attainable only by following a single line of approach. Others who have replied to us seem to believe that, for a student of engineering, nothing is worth the time acquired that is not definitely and narrowly a part of his equipment for his wage-earning task. Educators today generally recognize that the education of any individual is the whole process of his development, into which each subject, to be of real value, should be fitted with due regard for proper coördination with all his individual interests, activities, and future possibilities. Just how far and in what ways this means the adaptation of the engineer to English or the adaptation of English to engineers are questions that need further study.

3. If we may judge by the replies received, not enough attention has yet been given to the bearing of *the grade of the technical course* of which the English is a part. An engineering school may be postgraduate, undergraduate, or (confessedly or actually) below collegiate grade. It may consider all "general education" a matter of entrance requirement; it may give some academic training along with but distinctly separate from the professional; or it may attempt to give general education through and as an essential part of the professional studies. English, more than any other subject probably, is concerned in these distinctions. If an institution is satisfied with students who write English no better than any shop-trained mechanic, it implies (but probably would not

admit) that it is giving in so far a trade-school course. When another school says, "We require adequate English for entrance, giving it only incidental attention in course," it implies (possibly without fully appreciating the implication) that it considers English a subject that can be satisfactorily mastered before the student has attained more than high-school immaturity or has even begun his special studies. If the only attempt made to train the students to write on technical subjects is to require them to study Huxley, the implication would seem to be that all but purely literary paths are no thoroughfare. If a teacher says, "I will give your students any training in English you engineers want, after I have given them the essential, fundamental instruction that I, as teacher of English, know every educated man should receive," he implies that a professional student, even in an otherwise undergraduate school, can get no English training of real value in connection with his special work unless he has first taken a collegiate course. In defense of each of these grade interpretations much may be said, but the replies we have received would seem to indicate that many have not yet clearly recognized that such differences exist.

4. In the last place, much of the vagueness in the replies to our questionnaire seems to be due to the fact that even the answerers have not seriously enough asked themselves, "What is English?" To one teacher, this term may mean as distinctly a fine art as "oil-painting"; to another, it may signify nothing more than a consistent adoption of the standard way of spelling and using marks of punctuation. When two persons get into hot dispute over the subject of English, it will generally be found that the term means to each a distinctly different thing, and very likely neither appreciates that there is any rational understanding of the term but his own. Not only are there differences of this sort between different institutions, but there are notable cases where they exist between different teachers in the same school. Though they are co-sharers in the responsibility for the English training of engineers, they cannot speak the same language. Little prog-

ress can be made in determining whether English is a fundamental subject in the education of engineers till the term "English" is defined with some care. Even the incomplete data on this point that the Committee will soon be able to publish is interesting and enlightening.

SUGGESTION OF A METHOD FOR FURTHER INVESTIGATION.

The attention that has already been paid by many to the questions asked by this Committee would seem in itself to have brought about something in the way of clearer understanding, and the tabulated replies, when published, will give more definite suggestion. There will still be much, however, that needs to be done to overcome the lack of intelligent consensus of opinion. The general topics about which there seems to be indefinite disagreement might be announced, one at a time, through the columns of the BULLETIN, with the request that those interested in the subject send to the Committee their contributions to the discussion. The object would not be even ultimately to set up a method that anyone would be expected to subject himself to; rather it would be to define the various problems clearly and in some detail, and to evolve, from the experience of the most successful teachers, a standard by which any teacher of English could intelligently test his own opportunities, methods, and results.

Respectfully submitted,

SAMUEL C. EARLE,
Chairman.

PRELIMINARY REPORT OF COMMITTEE NO. 13, MECHANICS AND HYDRAULICS.

COMMITTEE.

E. R. MAURER, *Chairman*, Univ. of Wisconsin, Madison, Wis.,
L. M. HOSKINS, 365 Lincoln Ave., Palo Alto, Cal.,
S. M. WOODWARD, Care of Morgan Engineering Co., Dayton, O.,
C. E. FULLER, Mass. Inst. of Tech., Boston, Mass.,
WM. KENT, 64 Orange Road, Montclair, N. J.,
H. F. MOORE, Univ. of Illinois, Urbana, Ill.,
J. E. WADSWORTH, 22 Morseniese Place, Yonkers, N. Y.

PRELIMINARY REPORT OF COMMITTEE NO. 13.

Editor's Note.—The following questionnaire was sent out by this Committee. The replies will be used as a basis of the report which will be presented at the Virginia meeting.

QUESTIONNAIRE.

1. Please define the content and scope of the courses given at your institution in mechanics by stating for each of the following subjects:
   (*a*) The text book that most nearly fits the work; and
   (*b*) The total number of hours devoted to each subject and its position in the course.
      A. Elementary mechanics.
      B. Analytical mechanics.
      C. Mechanics of materials.
      D. Strength of materials.
      E. Materials of construction.
      F. Hydraulics.
      G. Graphical statics.
2. What department or departments teach mechanics?

   Inasmuch as "department" is not used in the same sense at all schools, it is suggested that "staff" be used instead; thus, mathematics staff, physics staff, mechanical engineering staff. If all the teaching in mechanics is done by one person, then he should be named by title.
3. *What experiments have been made in the methods of teaching mechanics?*

   Please make your statement brief and ready for publication.
4. *What means were used to test these experiments in teaching mechanics?*

   See remark under 3.
5. *Please send us typical lists of examination papers in the various groups A, B, C, etc.* Label them *A, B, C,* etc., if the letter is appropriate. Add any remarks necessary to make clear the scope (of subject matter) covered by the examination.

PRELIMINARY REPORT OF COMMITTEE NO. 14, ECONOMICS.

COMMITTEE.

J. A. L. WADDELL, *Chairman*, 800 Graphic Arts Bldg., Kansas City, Mo.,
MORRIS KNOWLES, Oliver Bldg., Pittsburgh, Pa.,
F. A. FETTER, Princeton Univ., Princeton, N. J.,
M. E. COOLEY, Univ. of Michigan, Ann Arbor, Mich.

Editor's Note.—The following questionnaire was sent out by this Committee. The replies will be used as a basis of the report which will be presented at the Virginia meeting.

QUESTIONNAIRE.

A new committee on the teaching of economics has been constituted in the Society for the Promotion of Engineering Education. We feel sure that you will be interested in the purposes of this committee, and we count upon your assistance in its work. We should be very glad if you would give us your ideas on the following questions, specifically if possible, otherwise generally—in any case please give us your ideas:

1. What courses in economics are taught to your engineering students?
2. Please outline the main topics covered in each course.
3. Which of these are required and which are elective?
4. Are these all taught regularly every year; if not, what are the exceptions?
5. Are the same required (or obligatory) courses given to the students in the various divisions of engineering (civil, mechanical, electrical, etc.)? If not, what differences are made?

By the aid of your answers we hope to formulate a plan for a more complete investigation of this important subject. Obviously the result of this committee's work can be of value only insofar as it succeeds in expressing the views of those with whom it would lie to put conclusions into effect.

Have you not some suggestions as to the best way the committee should proceed in its work?

PRELIMINARY REPORT OF COMMITTEE NO. 16, MECHANICAL ENGINEERING.

COMMITTEE.

A. M. GREENE, JR., *Chairman*, Rensselaer Poly. Inst., Troy, N. Y.,
C. RUSS RICHARDS, University of Illinois, Urbana, Ill.,
W. H. MEEKER, Iowa State College, Ames, Ia.,
C. C. THOMAS, University of Wisconsin, Madison, Wis.,
E. J. FERMIER, A. & M. College of Texas, College Station, Tex.

Editor's Note.—The following questionnaire was sent out by this Committee. The replies will be used as a basis of the report which will be presented at the Virginia meeting.

QUESTIONNAIRE.

1. How much shop work is given each year in actual hours?
2. What is the sequence of the divisions of shop work?
3. How much work is given to each division of shop work?
4. What is the amount of shop time for one day for one student?
5. What is the method of instruction? (*a*) Lecture, (*b*) Demonstration, (*c*) Individual work?
6. What amount of collateral reading is required?
7. What books are used?
8. How do students record collateral readings and observations therefrom?
9. How many men are in one section?
10. How many men are handled by one instructor?
11. What is the number of instructors in your institution giving shop work?
    What is the number of students using the shop in one year? How many courses require shop work?
12. What is the nature of the work done?
    Exercises illustrating principles .....
    Parts of commercial products .....
    Parts of a machine built in shop .....
13. What is the size of the work? (*a*) large, (*b*) medium, (*c*) small.

14. What is the number and value of machine tools used in shop?
    (*a*) Wood .....
    (*b*) Machine .....
    (*c*) Foundry .....
    (*d*) Forge .....
    (*e*) Miscellaneous .....
15. Are all tools used by the students?
16. What tools are used by instructors only?
17. Do you check tools from a tool room?
18. Do your students sharpen their own tools?
19. How is the student's passing determined in the courses in shop work? (Definite set of exercises—definite number of hours—judgment of instructor on indefinite amount of work.)
20. What degree of accuracy is required as far as dimensions are concerned?
21. What emphasis is placed on the kind of finish given to the exercises?
22. Is the report on the work done by the students in shop work given as passed or failed or is it reported with different grades? How are these grades reported? Give form.
23. What disposition is made of the student's shop work?
24. To what extent can satisfactory work in commercial shops be arranged for in summer vacations?
25. To what extent can this be made to take the place of college or university shop work?
26. What are the underlying reasons for including shop work in engineering courses?
27. What particular training, mental or manual, is the shop work designed to give the student?
28. Have results demonstrated that the shop has fulfilled its mission as given under No. 26 and No. 27? If so, state proofs. If not, state why and in what respect.
29. Do you consider that traditional shop courses prepare the student for facing modern industrial conditions?

30. Is it important that a prospective engineer learn to perform a shop operation or to operate a machine? Why?
31. Should shop operations be performed without definite relation to elements of time and cost?
32. Is the shop exercise performed for the training involved in manual skill or to illustrate certain principles?
33. Can shop work be successfully taught in laboratories equipped with old or obsolete machinery and by methods that do not prevail in well-organized commercial shops?
34. If methods are not equal to commercial practice and tools not in shape to turn out maximum quality of work, is there any danger that the course may be detrimental to the student?
35. Are the shop courses planned so that work in the various shop departments is part of a general scheme?
36. Are courses in departments administered independently of each other?
37. Are shop courses designed to train executives?
38. Are students given training in the following:
    (*a*) Routing work through shops and departments.
    (*b*) Dispatching same.
    (*c*) Inspecting material.
    (*d*) Inspecting workmanship.
    (*e*) Testing the materials used.
    (*f*) Methods of storing materials and keeping records of same.
    (*g*) Modern tool production method.
    (*h*) Efficient methods of operating machinery.
    (*i*) Calculating shop costs.
    (*j*) General manufacturing methods.
    (*k*) Methods of machine, tool and plant upkeep.
    (*l*) Modern methods of rewarding labor.

    State of what the training in each of these subjects consists.
39. Do you use time clocks or time cards?

40. Do you operate shop instruction cards made from time studies?
41. Do you have students act as foremen or speed bosses?
42. Do you study student's work for fixing time?
43. Do you use the shop to study shop management? In what year is this done? What has been the result of such work?
44. Have you made any machine studies in the art of cutting metal? What were these? What class was used to make these? Was the investigation satisfactory?
45. Do you do any other laboratory work in the shop?
46. Is there any coördination between the shop work and that of any department?

PRELIMINARY REPORT OF COMMITTEE NO. 17, ELECTRICAL ENGINEERING.

COMMITTEE.

C. F. SCOTT, *Chairman*, Sheffield Scientific School, New Haven, Conn.
C. L. CORY, Univ. of California, Berkeley, Calif.
C. F. HARDING, Purdue Univ., LaFayette, Ind.
C. R. DOOLEY, W. E. & M. Co., East Pittsburgh, Pa.
G. B. THOMAS, Colorado College, Colorado Springs, Colo.
F. B. JEWETT, 463 West St., New York, N. Y.
A. L. ROHRER, General Electric Co., Schenectady, N. Y.

QUESTIONNAIRE.

December, 1915.

Dear Sir: "Students ought to realize that the things which to them may seem useless may be of the greatest importance to their future progress." So said a man of experience a few weeks ago.

What are the things on which engineering graduates place a new value in the light of their experience in real life? How can the student of today and his professors gain the point of view of the graduate and lay emphasis on the best things? What message has the graduate for the present student and for the professor?

A number of graduates have replied that the things of most

value to them were "learning how to study," "the literary society," "economics," "mathematics," "written reports," "notes taken of lectures by professors and others," "English composition," "the ability to attack a complex problem," "lectures by men in practice," "contact with others in organization, *e. g.*, a rifle club," "handling men in the cadet corps," "student branch S. P. E. E.," "association with the engineering faculty," "outside work to earn school expenses."

Many of these things are totally outside the prescribed curriculum. Students are apt to neglect these outside things and to confine their attention to the prescribed course. Professors realize this and will welcome suggestions for their own guidance and statements from graduates which may give the student a new viewpoint.

The Electrical Engineering Committee of the Society desires the views of successful men whose reasonably mature point of view carries weight, in order that these views may be presented to student and to teacher.

The Committee requests your aid by asking that you secure from a selected number of men in your employ comments on the following topics.

From your present point of view as you look back upon your life and development while in college, what do you consider benefited you most? Why?

First. In the regular curriculum.

Second. In other phases of your college life.

Please state the nature of your present work, the name of college and year of graduation.

If it happens that you should make any summary or classification of replies received, the Committee will be very glad to have the results, as it will lessen the burden which a mass of unclassified replies will place upon it.

Replies should be sent to the Committee by February 15, 1916.

REPORT.

The Electrical Engineering Committee held several sessions at which the majority of the members were present, and after

consideration of various plans determined on the following schedule, which was approved by the other members of the committee. The three items decided upon are as follows:

1. Short contributions to the BULLETIN were invited relating to methods or appliances in electrical engineering instruction. Several have been received and have either been published or await publication.

2. Sequence of instruction in alternating current and in direct current; which should come first? Continuation of discussion from last Convention, to which contributions were invited. One has been received from Professor William Kent. It is as follows:

Prof. C. F. Scott, *Chairman,*

Dear Sir: I notice in the BULLETIN of the S. P. E. E. that you are inviting contributions to the subject of the methods of teaching electrical engineering. Here are a few of my ideas on the subject.

A. Direct current is not a special case of alternating current any more than the silence of a tuning fork at rest is a special case of the sound it produces while vibrating; or than rest is a special case of motion, or than the uni-directional motion of a fly-wheel is a special case of the to-and-fro motion of the ball of a pendulum.

B. Begin the study of electrical physics by taking a tumbler containing acidulated water, a strip of copper and one of zinc, and a piece of copper wire. Show by a galvanometer needle that something is happening in or around the copper wire. Put several batteries in series and in parallel and show the effect on two measuring instruments, voltmeter and ammeter (don't explain these instruments yet). Wrap the copper wire around a thermometer and show heating effect. Short circuit with a thin wire and show light and fusion. Show how the magnitude of these effects depends on the series and parallel arrangement of the batteries. Make and break the circuit and show sparks. Show a horseshoe magnet and its picking up nails. Wrap the copper wire around an iron bolt and show that the bolt becomes a magnet. Make a magnet with a

wide flat pole piece, so that it has a magnetic field of uniform intensity over a considerable area. Drag a wire across this field in one direction and show that a direct current is made in the wire. Show that the voltage decreases as the wire passes into a weak portion of the field. Drag the wire across the field again, but in the reverse direction, and show that a similar direct current is produced, but that the galvanometer needle shows that its direction is reversed. Now take two pole pieces *N* and *S*, placed some distance apart, and move the wire in a path across the front of one pole and back across the front of the other pole. Show how the direct current of uniform intensity, made while the wire is passing across the middle part of *N*, is changed to 0 voltage as it passes around the curve at *A* and increases to *V* maximum when it gets into the horizontal path above *S*, and that its direction is reversed. It is now an alternating current of three periods: (1) Direct and positive; (2) Changing from $+V$ to 0 and then to $-V$; (3) Direct and negative. The alternating current is thus a special case of direct current. When the path of the wire is circular the ordinary alternating current is made.

In this way go through the whole series of the important electrical phenomena in an experimental way, so as to give the student clear and fixed conceptions of elementary electrical facts before he is troubled with theory, measurements, mathematics, etc. Then teach electrical engineering, direct current before alternating current, because it is easier and simpler, and does not require higher mathematics. The experimental study of alternating current machines may, however, be carried on at the same time as the experiments on direct current machines, the theory and design of alternating current machines and transmission being postponed till later in the course. (Signed) WM. KENT.

3. A questionnaire based upon the following: "From your present point of view as you look back upon your life and development while in college, what do you consider benefited you most? Why?

"*First.* In the regular curriculum.

"*Second.* In other phases of your college life.

"Please state the nature of your present work, the name of college and year of graduation."

It was the intention to submit these questions to a few selected graduates capable of forming a worth while judgment and who have been away from college a reasonable length of time. It was anticipated that in the replies received there would be valuable suggestions, both to teachers and to students. The values set upon various elements of college life by the graduate should be a directing influence with the better class of students. The request was sent to a dozen manufacturing, operating or engineering companies. Returns have been received from the Commonwealth Edison Co., the Philadelphia Electric Co., and the Westinghouse Electric & Manufacturing Co.

The individual replies indicate various points of view and will be serviceable when finally classified and summarized.

The report for the Commonwealth Edison Co. concludes with this summary, which is the "General opinion of group of engineers, graduates of Massachusetts Institute of Technology, Armour Institute, University of Illinois, Ohio State University, etc."

What was of most benefit in the college curriculum?

"Mental training acquired through hard study of rather diversified subjects resulting in giving one the ability to comprehend and grasp problems and situations and to study out complex problems."

What was of most benefit of other phases of college life?

"The association with a large number of fellow students in a manner of intimacy hardly possible under circumstances other than college life, resulting in the ability to judge personal characteristics and character in a way that in itself constitutes a liberal education."

CHAS. F. SCOTT,
Chairman.

PRELIMINARY REPORT OF COMMITTEE NO. 18, MINING.

COMMITTEE.

F. W. SPERR, *Chairman*, Mich. School of Mines, Houghton, Mich.
E. A. HOLBROOK, Univ. of Illinois, Urbana, Ill.
J. B. PORTER, McGill Univ., Montreal, Canada.
H. H. STOEK, University of Ill., Urbana, Ill.

Editor's Note.—The Committee feels that it is very important that its questionnaire be carefully considered before being distributed. It submits, therefore, the following questionnaire as its preliminary report to the Virginia meeting and asks that it be considered and discussed as such.

QUESTIONNAIRE.

LABORATORIES FOR UNDERGRADUATE STUDENTS IN MINING ENGINEERING.

Aside from the regular physics, chemical and geological laboratories, check the various laboratories in which the undergraduate mining engineer takes practice, and indicate whether the laboratory work is required (Req) or elective (El).

(1) Assaying and Analysis:
(2) Ore Dressing:
(3) Metallurgical:
(4) Mining (including field work, surveying and otherwise, aside from inspection trips):
(5) Other laboratories (including all general engineering laboratories and field surveying). Give number of hours in each and indicate whether required or elective:
   (*A*) Mechanical—"shops."
   (*B*) Electrical:
   (*C*) Hydraulic:
   (*D*) Power:
   (*F*) Surveying:
   (*G*)

What are the usual groups of electives?

PRELIMINARY REPORT OF COMMITTEE NO. 18.

1. *Assaying and Analytic Laboratory (Not the Regular Qualitative and Quantitative Chemistry).*

Apparatus—Sampling and Grinding Machinery, Furnaces, etc.								
List Below.	Check in Proper Column by Whom							Remarks.
	Prepared.		Operated.		Cleaned.			
	Student.	Instructor.	Student.	Instructor.	Student.	Instructor.		

2. *Ore Dressing Laboratory.*

Apparatus—List Below and State Whether Machines are Commercial Size or Small.	Check in Proper Column by Whom							Remarks.
	Prepared.		Operated.		Clean-up is Made.			
	Student.	Instructor.	Student.	Instructor.	Student.	Instructor.		

3. *Metallurgical Laboratory.*

If several courses are given, make a separate report for each course.

Apparatus, Furnaces, Etc., List Below and Give Sizes.	Check in Proper Column by Whom						Remarks.
	Prepared.		Operated.		Clean-up is Made.		
	Student.	Instructor.	Student.	Instructor.	Student.	Instructor.	

4. *Mining Laboratory.*

Check the various divisions in which you give laboratory instruction and give respective importance (by per cent.) of each.

Division.	Req.	El.	Impt. Per Cent.	Remarks.
(*a*) Drilling				
(*b*) Explosives				
(*c*) Timbering (supporting)				
(*d*) Mine gases, safety lamps, and Explosibility of dust				
(*e*) First aid and rescue				
(*f*) Work in mines				
(*g*)				
Total			100 per cent.	

What machines, apparatus, etc., are used in each of the above?

Laboratory Uses and Practices.

Give Answer in Each Column to Which Question Applies for Each Laboratory or Sub-division.	(1) Assaying.	(2) Ore Dressing.	(3) Metallurgy.	(4) Mining.						
				(a)	(b)	(c)	(d)	(e)	(f)	(g)
Is the course illustrative (work done by the instructor).....										
or										
Is the work done by the students.....										
Is the laboratory work individual.....										
or										
Is it in units.....										
Does the student follow printed directions.....										
or										
Is he dependent on his own initiative in carrying on the work.....										
Does the student prepare his own material for the tests										
Does the student prepare his reagents.....										
Does the student analyze his products (2) and (3).....										
Is most of the work illustrative (2) and (3).....										
or										
Is it determinative and quantitative.....										
Is especial attention given to any class of ores, or the ores of any particular metal (1), (2) and (3)..										
or										
Is the work of the laboratory generalized.....										
Do the students make their tests with individual machines or furnaces (2) and (3).....										
or										
Do they run several machines or furnaces in sequence at once.....										

Give Answer in Each Column to Which Question Applies for Each Laboratory or Sub-division.	(1) Assaying.	(2) Ore Dressing.	(3) Metallurgy.	(4) Mining.						
				(a)	(b)	(c)	(d)	(e)	(f)	(g)
Is the laboratory equipped for commercial testing work (2) and (3) and (4).										

Academic Uses and Practices.

Give Answer in Each Column to Which Question Applies for Each Lab. or Sub-division.	(1) Assaying.	(2) Ore Dressing.	(3) Metallurgy.	(4) Mining.						
				(a)	(b)	(c)	(d)	(e)	(f)	(g)
Approximate apportionment of student's time in hours at instructions:										
Reading assignments.....										
Printed or written matter										
Oral and illustrative—										
In recitations.....										
In lectures.....										
In laboratory.....										
At mere manual work, such as shoveling, etc...										
At writing report.....										
Are the laboratory hours regularly scheduled.....										
or										
Are they adjusted to suit the convenience of other work, from time to time.....										
Does the student originate the style of his report....										
or										
Are blank forms used.....										

PRELIMINARY REPORT OF COMMITTEE NO. 19.

Proportionate Emphasis Placed.

(Estimated in Percentage.)

Give Per Cent. in Each Column to Which Question Applies for Each Lab. or Sub-division.	(1) Assaying.	(2) Ore Dressing.	(3) Metallurgy.	(4) Mining.						
				(a)	(b)	(c)	(d)	(e)	(f)	(g)
Proficiency in the use of apparatus—										
Speed										
Accuracy										
Knowledge of principles involved—										
Chemical										
Mechanical										
Construction										
Action										
Understanding of proper field										
Initiative in new problems										
Subject matter and arrangement of report										
Other considerations										
Total	100	100	100	100	100	100	100	100	100	100

The answers will not be published as such: they will be used to determine the average academic practice in laboratory instruction for undergraduate mining engineers. It is the intention to publish the averages.

F. W. SPERR,
E. A. HOLBROOK,
J. B. PORTER,
H. H. STOEK.
Mining Committee.

PRELIMINARY REPORT OF COMMITTEE NO. 19, STATISTICS.

Editor's Note.—A report based upon answers to the following questionnaire was printed in the April BULLETIN, reprints of which will be available at the Virginia meeting.

QUESTIONNAIRE.

Dear Sir: The Committee on Statistics has been asked to report to the Society for the Promotion of Engineering Education on matters covered by the following questions.

PRELIMINARY REPORT OF COMMITTEE NO. 20.

I. What record does your college keep of the withdrawal of students during the year?

II. What record does your college keep of the ratio of those who enter the college in any given class to those who graduate from the college?

III. Does your college employ an alumni secretary?

IV. What are the chief duties of this secretary?

V. What studies have been made, or are being made, of students' scholarship records, either by your institution or by the members of your faculty? This question refers to any special study, as division of hours, rank and promotion, student organizations, etc.

VI. What studies noted in your answer to Question V are at the disposal of members of the Society and from whom may they be obtained?

VII. What other work along the line of statistical studies is being made at your institution?

We will appreciate your coöperation in furthering this work and request that a reply to the above be made by January 15, 1916.

COMMITTEE ON STATISTICS,

A. J. WOOD,
Chairman.

PRELIMINARY REPORT OF COMMITTEE NO. 20, TECHNICAL NOMENCLATURE.

COMMITTEE.

J. T. FAIG, *Chairman*, University of Cincinnati, Cincinnati, O.
S. C. EARLE, Tufts College, Tufts College, Mass.
W. D. ENNIS, Poly. Inst. of Brooklyn, Brooklyn, N. Y.
F. N. RAYMOND, Univ. of Kansas, Lawrence, Kans.
D. M. WRIGHT, 52 Irving St., Hartford, Conn.

The purpose of this Committee is not to impose arbitrary standards upon others, but to secure agreement throughout as wide a circle of technical men as possible, on the spelling, hyphenating and abbreviating of disputed technical terms.

A preliminary report, which may be found in the *Proceedings* for 1915, Society for the Promotion of Engineering Education, was presented by the Committee at the annual meeting in June, 1915. Following is a list of writers, teachers and engineers who have sent criticisms of the preliminary report, have supplied additional technical words for future lists or have aided the Committee by suggestions.

W. H. Adams, Professor of Mechanical Engineering, Throop College of Technology, Pasadena, Cal.

K. F. Adamson, Assistant Professor of Mechanical Engineering, Case School of Applied Science, Cleveland, Ohio.

J. R. Allen, Professor of Mechanical Engineering, University of Michigan, Ann Arbor, Mich.

H. C. Anderson, Consulting Engineer, 86 Park Place, Newark, New Jersey.

James Aston, Metallurgist, Bureau of Mines, Pittsburgh, Pa.

Fred E. Ayer, Dean, College of Engineering, University of Akron, Ohio.

C. H. Benjamin, Dean of the Schools of Engineering, Purdue University, LaFayette, Ind.

J. E. Boyd, Professor of Mechanics, Ohio State University, Columbus, Ohio.

J. P. Brooks, President, Clarkson College of Technology, Potsdam, N. Y.

D. E. Carpenter, Manager of Education, International Correspondence Schools, Scranton, Pa.

C. H. Chase, Professor of Steam Engineering, Tufts College, Mass.

W. H. P. Creighton, Dean of College of Technology, Tulane University, New Orleans, La.

Chas. Day, Manager, Day & Zimmerman, Engineers, 608 Chestnut Street, Philadelphia, Pa.

Hugo Diemer, Professor of Industrial Engineering, Pennsylvania State College, State College, Pa.

H. E. Ehlers, Professor of Experimental Engineering, University of Pennsylvania, Philadelphia, Pa.

F. L. Emory, Professor of Mechanics and Applied Mathematics, West Virginia University, Morgantown, W. Va.

E. A. Fessenden, Associate Professor of Mechanical Engineering, University of Missouri, Columbia, Mo.

Thos. E. French, Professor of Engineering Drawing, Ohio State University, Columbus, Ohio.

F. DeR. Furman, Professor of Mechanism and Machine Design, Stevens Institute of Technology, Hoboken, N. J.

G. A. Goodenough, Professor of Thermodynamics, University of Illinois, Urbana, Ill.

A. M. Greene, Jr., Professor of Mechanical Engineering, Rensselaer Polytechnic Institute, Troy, N. Y.

J. L. Harrington, Consulting Engineer, Kansas City, Mo.

H. W. Hibbard, Professor of Mechanical Engineering, University of Missouri, Columbia, Mo.

H. H. Higbie, Professor of Electrical Engineering, University of Michigan, Ann Arbor, Mich.

Chas. W. Hunt, Secretary, American Society of Civil Engineers, 220 West 57th Street, New York.

V. Karapetoff, Professor of Electrical Engineering, Cornell University, Ithaca, N. Y.

Wm. Kent, Consulting Engineer, 64 Orange Road, Montclair, New Jersey.

J. N. LeConte, Professor of Engineering Mechanics, University of California, Berkeley, Cal.

O. A. Leutweiler, Assistant Professor of Machine Design, University of Illinois, Urbana, Ill.

L. V. Ludy, Professor of Experimental Engineering, Purdue University, LaFayette, Ind.

W. T. Magruder, Professor of Mechanical Engineering, Ohio State University, Columbus, Ohio.

L. S. Marks, Professor of Mechanical Engineering, Harvard University, Cambridge, Mass.

J. S. Mathewson, Instructor in Engineering, University of Akron, Ohio.

W. L. Miggett, Professor of Shop Practice, University of Michigan, Ann Arbor, Mich.

C. W. Park, Assistant Professor of English, College of Engineering, University of Cincinnati, Cincinnati, Ohio.
G. W. Pickels, Jr., Instructor in Civil Engineering, University of Illinois, Urbana, Ill.
C. P. Poole, Consulting Engineer, Atlanta, Ga.
C. R. Richards, Professor of Mechanical Engineering, University of Illinois, Urbana, Ill.
A. R. Sawyer, Professor of Physics and Electrical Engineering, Michigan Agricultural College, East Lansing, Mich. of Nevada, Reno, Nev.
J. G. Scrugham, Dean of College of Engineering, University
F. H. Vose, Professor of Mechanical Engineering, Case School of Applied Science, Cleveland, Ohio.
J. A. L. Waddell, Consulting Bridge Engineer, Kansas City, Mo.
F. C. Wagner, Professor of Electrical and Mechanical Engineering, Rose Polytechnic Institute, Terre Haute, Ind.
W. O. Wiley, Publisher of Scientific Books, Secretary John Wiley & Sons, New York City.
A. M. Wilson, Professor of Electrical Engineering, University of Cincinnati, Ohio.

The following organizations and publishers have been consulted or have supplied the Committee with the results of their own labors on similar work.

American Society of Civil Engineers.
American Institute of Electrical Engineers:
Standard Abbreviations and Notations; edition February, 1913.
Standardization Rules, December 1st, 1914.
American Society of Mechanical Engineers.
Public Printer of the United States. (Style Book.)
National Electric Light Association.
John Wiley & Sons.
The Engineering Magazine.
Machinery.

The criticisms of the words in the Preliminary Report that were sent in by various teachers and engineers showed wide

differences of opinion. Each word was written on a card and all of the criticisms and suggestions relating to a particular word were written on the card assigned to it. Differences of opinion were thus easily seen.

A great lack of agreement in the use of the hyphen and in the compounding of words generally was found. As far as a trend is discernible in the data gathered, the trend is toward simplification of language and omission of the hyphen.

A paper by Professor C. W. Park in the November, 1915, number of the BULLETIN on "The Writing of Compound Technical Terms," and a paper by Mr. D. E. Carpenter in the February, 1916, number of the BULLETIN, on " Compound Technical Terms," have stimulated discussion of technical nomenclature in general and an understanding of the difficulties introduced by the use of compound words in particular.

Some of the technical journals of the United States show a tendency to hasten the process of combining two words into a solid word. This process usually requires generations and is characterized by an intermediate hyphenated stage. Sometimes the extent to which terms have progressed from the separated form to the inseparable form is a matter upon which there is no substantial agreement. The word *horsepower* has been used for over a hundred years. It has now the force of a scientific unit among engineers, and yet it is variously printed as *horse power, horse-power, horsepower.* The reason why the inseparable form is not universally given is doubtless that the general public do not recognize it as a distinct entity, as they do, for instance, *railroad.* The reason for urging a change to the inseparable form in the case of *horsepower* seems good, because it is a scientific unit of measurement. A similar case is that of the word *candlepower,* which is sometimes written as two words. But words like *wheelbase* and *underframe* do not seem to have the same justification for the inseparable form, and it is doubtful whether it is wise to write them in this way at the present time.

In the interests of simplicity it would seem intelligent never to write two words in the inseparable form unless they

make a definite scientific unit, or unless they have become so definitely established in current usage that they are given the inseparable form by lexicographers. There is one exception to this, which already has been noted but which will be repeated here. When a compound term becomes a simple definite scientific unit, it should be written in the inseparable form. When the term becomes a complex unit, as for instance, *horsepower-hour,* a hyphen should be used.

The conclusions contained in this report were sifted out of the study of many question, with a view to finding such as would be safe. Many other puzzling forms are being studied, as is shown in the list of "Words not Approved." The questions seem to bring out some features of language morphology not treated in the reference books available. The basis for judgment on these will have to be attained by study and experience in the Committee and by consultation with scholars who have made researches into the nature of language touching these problems. General rules, also, can hardly be formulated until such further study is made. Members of the Society are urged to refer to the Committee questions of language use which may provide such experience.

The following rules represent an effort to express the general tendency shown in the criticisms of the preliminary report of 1915. It must be borne in mind that the differences of opinion shown by the cards preclude the possibility of formulating any set of rules that will secure universal approval. The rules allow sufficient latitude to harmonize existing differences until entire conformance with them, or some other set of rules, is secured.

Rules for Compound Technical Terms.

1. Omit hyphens with compound nouns. Example, *railroad.*
   Exceptions:
   (*a*) When a compound noun is composed of two or more words, each of which is a distinct engineering unit. (As *kilowatt-hour, ton-mile.*)

(*b*) When a term that should be written as one word cannot be so written because of the awkward appearance it would present. (As *straightedge.*)

2. Do not write a compound noun as one word unless it is so given generally in dictionaries. Example, *boiler room.*

Exceptions:

(*a*) When the term is a scientific unit. (As *candlepower, horsepower.*)

3. Omit hyphens with adjective compounds, except when the meaning is not clear without the hyphen. Exceptions usually fall under two heads.

(*a*) Where ellipsis occurs. (As *first-class.*)

(*b*) Where the adjectives separately fail to convey the correct meaning. (As *water-tube* boiler.)

The following words are approved by the Committee as to spelling, hyphenating, and abbreviations. It is recommended that the forms shown be adopted for all publications of the Society and that members be urged to use them in their notes, articles, and books.

THESE WORDS ARE APPROVED BY THE COMMITTEE.

air compressor		4
alloy steel		1
adjustable-speed motors	(**adjustable-speed** as adjective)	9
alternating current	spell out (**a.c.** when used as a compound adjective)	8
ammeter		9
amperes	**amp.**, or spell out	
asphaltic contents		10
bevel gear		4
blister bar		1
boiler horsepower	**boiler hp.**	
boiler room		4
brake horsepower	**b. hp.**	
British thermal unit	**B.t.u.**	3
Brown and Sharpe gage	**B. & S. gage**	
candlepower	**cp.**	

carbon steel	as noun	1
cast steel	as noun or adjective	4
cast iron	as noun or adjective	1, 4
cement bar		1
Celsius	C.	3
centimeters	cm.	8
circular mils	cir. mils (c.m. in tabular matter)	8
clutch coupling		
clutch pulley		7
coal tar	as noun or adjective	10
coke oven tar		10
compound gears		2
cone gear		2
connecting rod		4
constant-speed direct current motors		
constant-potential transformers		9
constant-speed motors	(constant speed as adj.)	9
continuous current	as noun	9
converted bar		1
counter clockwise convention		
counter-electromotive force	counter e.m.f.	8
crank pin		4
crank shaft		4
cubic	cu.	8, 3.
cut-off		4, 7.
diameter	spell out	8
direct current	spell out (d.c. when used as compound adjective)	8
drafting room		4
electric horsepower	e. hp.	
electromotive force	e.m.f.	8, 3
engine room		4
equivalent sine wave		9
face gear		2
Fahrenheit	F.	
ferro alloys		1
feet	ft.	8, 3
figure	Fig.	3
fire tube	as noun	4
flywheel		7
follower guide		2
follow rest		2
foot-pounds	ft-lb.	8, 3

gallons	gal.	3, 8
gas engine		4
gas producer		4
gas regulator		4
gas turbine		4
gear guards		2
grains	gr.	3, 8
gram-calories	g-cal.	
grams	g.	8
gray cast iron		1
headstock		2
high-duty	as adjective	4
high pressure cylinder	spell out	3
high-priced		4
high-speed		4
horsepower	hp.	
horsepower-hours		
hot water heating system		4
hot well		
hours	hr.	8
inches	in.	8, 3
index plate		2
indicated horsepower	i. hp.	
induction generator		9
induction motor		9
ingot iron		1
ingot steel		1
iron castings		1
kilogram	kg.	8
kilogram-meters	kg-m.	8
kilometers	km.	8
kilovolts	kv.	8
kilovolt-amperes	kv-a.	
kilowatts	kw.	3
kilowatt-hours	kw-hr.	
lathe bed		2
latent heat		4
linear	lin.	3
liquid asphalt	do not use	10
live-center		7
load factor		9
low-duty	as adjective	4
machine shop		4

magnetomotive force	m.m.f.	3, 8
malleable cast iron		1
mean effective pressure	m.e.p. in tabular matter	3
meters	m.	8
meter-kilograms	m-kg.	8
microfarad	spell out	8
miles	mi.	8
miles per hour per second	mi. per hr. per sec.	8
milligrams	mg.	8
millimeters	mm.	8
minutes	min.	3, 8
mixer metal		1
motor generator		9
mottled cast iron		1
multiple cylinder		4
multispeed motors		9
non-inductive load and inductive load		9
ohms	spell out	8
oscillating current		9
passenger car		4
per	spell out	8, 3
per cent	spell out (% in tabular matter)	3
percentage	per cent (% in tabular matter)	8
per cent drop		9
phase difference		9
pig iron		1
piston rod		4
plant factor		9
plated bar		1
pounds	lb.	8, 3
power factor		9
power plant		4
printing press		4
railroad car		4
revolutions per minute	rev. per min. (r.p.m. in tabular matter)	8
rod mill		4
rolling mill		4
second	sec.	3
semi-steel		
shear steel		1
short-circuit stresses		9
sine wave		9

specific heat		4
spindle feed gears		2
spur gear		4
square	sq.	8, 3
stay bolt		4
steam heating or heat		4
steam piping or pipe		4
step bearing		4
steam boiler		4
steam jacket		4
steam power plant		4
steam turbine		4
street car		4
street railway		4
stud gear		2
ton-mile	spell out	8
tons	spell out	8
tool block		2
tool post		
unipolar machines		9
United States gallon	U. S. gal.	3
valve gear		4
varying-speed motors		9
volt-amperes	spell out	8, 9
volts	spell out	3, 8
water meter		4
water power		4
waterworks		
watt-hours	watt-hr.	
watt-hour meter		9
watts	spell out	3, 9
watts per candlepower	watts per cp.	
white cast iron		1
wood block pavement		10
worm gear		4
wrought iron		4, 1
yards	yd.	8, 3
yield point		4

Miscellaneous Forms.

3 in. by 6 in.	7
3 in. long	7

3-in. valve..... 3-in. as adjective 7
one twenty-fifth 7
three sixteenths 7
three hundred twenty-two 7
twelve-inch main 7

1. From the report of committee 24, on uniform nomenclature of iron and steel, International Association of Testing Materials, Eighth Congress, New York, 1913. (Not accepted.)
2. Preferred names for lathe parts as determined by a ballot of builders of lathes. See *American Machinist*, April 24, 1913.
3. From the report of a committee to co-operate in standardizing abbreviations, symbols, punctuation, etc., in technical papers. *Proceedings of the American Society of Civil Engineers*, April, 1904 (Volume XXX, No. 4), pp. 174–177.
4. Taken from an old style sheet of the American Society of Mechanical Engineers.
5. From C. B. Going, editor, *The Engineering Magazine*.
6. Suggested by Mr. D. M. Wright.
7. From a list prepared by W. P. Cutter, librarian of the Engineering Societies. 29 W. 39th Street, New York.
8. A. I. E. E. standard abbreviations and notation, edition of February, 1913.
9. From Standardization Rules of the American Institute of Electrical Engineers. Edition of December 1, 1914.
10. Suggested by Mr. W. W. Crosby.

The following list of words has been compiled from various sources, many of which are indicated. These are to be considered by the Committee and such of them as are deemed worthy will be placed upon the approved list in later reports. Words marked * appeared in the preliminary report of 1915, but have not yet been placed on the approved list.

THESE WORDS HAVE NOT BEEN APPROVED BY THE COMMITTEE. THEY ARE GIVEN FOR CRITICISM AND SUGGESTIONS.

aboveboard 11
absolute..... **abs.** 14
acid-proof 11
airbound 11
air chamber 13
airdriven 11
air pump 13

airship 12
alcoholimeter 11
alcoholmeter 11
aline ..... not align 11
all-around 11
allbone 11
all-possessed 11
all right ..... not alright 12
allspice 11
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armor-plated 11
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baseplate		12
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bathtub		11
battleship		11
Baumé	not Beaumé	11
barrels	**bbl.**	14
Baume (degrees)	**Bé.**	14
bedplate		15
bedrock		15
bellcrank		12
bell-mouthed		12
belt drive		12
benzin	not benzine	11
beveled	not bevelled	11
Birmingham gage	**B. G.**	14
bib cock		11
Birmingham	**Birm.**	14
blacksmith		11
blacksmithing		11
blast furnace		13
blank-holder		12
blow-hole		12
blowoff		15
blow-off		11
blow-out		11
blowpipe		12
blue print*		4
boathouse		11
boilermaker		12
boilersmith		11
bonus		16
bookbinder		11
boring-bar		12
boring machine*		6
box-tool		12
brakeshoe		15
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brickbat		11
brickkiln		11
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brickmaker		11
briquet	not briquette	11

briqueted 11
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bromid 11
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bucketful 13
built-up 11
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busbar 13
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camshaft 15
cam-shaft 12
can not 11
canoewood 11
cantaliver..... not cantilever 11
capscrew 15
cap-screw 12
carbid..... not carbide 11
carbureter..... not carburetter 11
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cardboard 11
carload 11
carman 11
carriage-way* 10
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cast-weld 11
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centimeter-gram-second	c. g. s.	14
chainsmith		11
change-gear box*		2
chauffeur		11
cheap-john		11
check-nut		12
checkwork		11
cherry-wood		11
cheval-vapeur		11
chlorid		11
chlorin		11
cast iron	C. I.	14
classman		11
clay-working machinery*		6
clevis		11
cloakroom		11
clockwise		11
clockwork		11
coal dust		13
coefficient	coeff.	14
cogwheel		11
column(s)	col.	14
cold-drawn		11
cold-rolled		13
cologarithm of	colog.	14
compound	comp.	14
concentrated	conc.	14
condensing	cond.	14
condensable		11
conductible		11
connectible		11
control		16
controllable		11
conveyer	not conveyor	11
cone-shape		12
constant	const.	14
coöperate	not co-operate	11

copper-zinc		18
corkscrew		11
cosine of	cos	14
arc whose cosine is	$\cos^{-1}$	14
anticosine of	$\cos^{-1}$	14
inverse cosine of	$\cos^{-1}$	14
cosecant of	cosec	14
inverse hyperbolic cosine of	$\cosh^{-1}$	14
cost-keeping		13
cost reduction		13
cotangent of	cot	14
cottonwood		11
counterbalance		12
counterbore		12
counter-revolution		11
countershaft		17
coversed sine of	covers	14
craneman		11
cribwork		13
crossbar		11
crossbeam		11
crosshead		12
cross-peen		12
cross-rail		12
cross-section		12
crosswise	not crossways	11
cup-wheel		12
cutter-head		12
cutter-spindle		12
cyanid	not cyanide	11
cylinder	cyl.	14
deckle-edged		11
degrees	deg.	14
definition(s)	def.	14
diagrammatic	not diagramatic	11
die-bed		12
die-head		12
die-holder		12
dieing machine*		6
diemaker		12
diesinker		11
difference	diff.	11
dimension line		17

direct-connected engine*		7
direct-current compensator*		9
direct-current generator*		7
disk	not disc	11
dispatching		16
distance	dist.	14
distributed	dist.	14
distributer	not distributor	11
double-shear steel*		1
double track		13
dovetail		10
downdraft		17
downward	not downwards	11
draft		11
drafting board		13
draftsman		11
dragbar		11
drag-saw		11
dram	not drachm	11
drawbar		11
drawing-room	use drafting room	11
drier	not dryer	11
drilling machine*		6
drivebolt		11
driveshaft		17
drop-forging		12
drop-of-potential		13
drop-press*		4
dry-clean		11
dry-grind		11
dust guard		13
dustproof		12
eagle-sighted		11
effective horsepower		
efficiency	effy.	14
elastic limit	E. L.	14
electric	elec.	14
electro-engrave		11
electro-etching		11
electrolysis		11
electrolyte		11
electromagnet		12
electroplate		12

ell	12
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employee	11
end-mill	12
end thrust	13
end-thrust	12
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eyebeam	11
eyebolt	11
eyeleted	11
eyepiece	11
fabrikoid	11
face-arbor	11
face-harden	11
faceplate*	2
falsework	13
farther (distance)	11
feed	16
feed-box	12
feed-gear segment*	2
feed-rod gear*	2
feed-shaft	12
fiber	not fibre 12
finish-grind	12
finish-turn	12
fireback	11
firebox	12
firebrick	12
fireclay	12
fireproof	12

fivefold 11
five-leaf 11
flareback 11
flashlight 13
fluework 11
free on board..... F. O. B. 14
fool-proof 12
footbridge 11
footgear 11
footnote 11
foot-pound-second 11
footway* 10
foreman 13
former pin 12
framework 11
freeboard 11
freehand 17
freezing point 13
fretwork 11
friction clutch 13
frustum..... not frustrum 11
factor of safety..... F. S. 14
gangway 13
gas-fired 11
gas-house coal tar* 10
gasify..... not gasefy 11
gaslight 11
gate valve 13
generator room 13
glassmaker 11
go-between 11
gooseneck 12
gray 11
gridiron 11
grinding machine* 6
guncotton 12
hacksaw 12
half-hourly 11
half-nut 12
half-round 11
halftone 12
hallway 11

hammer-head*		4
hammer-wrought		11
hand-book		12
handhole		12
handmade		12
handwheel		12
handwork		11
hand-wrought		11
hard-drawn		11
headway		11
heat-treatment		12
heavy-duty		13
herringbone		11
high-potential		13
highroad		11
high-speed-tool steel		18
highway		11
hit-and-miss		11
hogback		11
hogchain		11
home-made		13
house-boat		11
hypotenuse	not hypothenuse	11
hysteresis		11
I-beam		19
ibidem	ib., ibid.	11
idem	id.	11
igniter		11
ignitible		11
imperial	imp.	14
incasing	not encasing	11
inch-pounds	in-lb.	14
inclosing	not enclosing	11
inclusive	inc.	14
indelible		11
india rubber		11
Indian Engineering Society	**Ind. Eng. Soc.**	14
inflater		11
infold	not enfold	11
input		13
insanitary		11
installing		11
instalment		11

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intake 13
intermediate gear* 2
intermediate-gear segment* 2
intermediate-gear stud* 2
intermediate-pressure..... i-p. 14
internal-combustion 11
International Congress of Applied Chemistry .....
Int. Cong. Appl. Chem. 14
International Society for Testing Materials .....
Int. Soc. Test. Mat. 14
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ironclad 11
iron-mold 11
ironmonger 11
iron-ship builder 11
ironwork 11
ironworker 11
isothermal..... isoth. 14
jackshaft 15
jack-screw 12
jam nut 11
jerry-built 11
journeyman 11
keyseat 12
keyway 12
kick-out 11
kiln-dry 11
kilos 11
landmark 11
lathe-bore 11
latticework 11
lay-by 11
lay-over 11
layshaft 17
leadscrew gear* 2
leather-working machinery* 6
leeway 11
left-hand 12
letter-perfect 11
levelman 11
lighted..... not lit 11
limit..... lim. 14

limekiln		11
limewater		11
line-drop voltmeter compensator		9
lineshaft		12
link-block		12
liquefy	not liquify	11
liter	not litre	11
loco citada (in the place cited)	**loc. cit.**	11
locomotive	**loco.**	14
locomotive engineer		13
logarithm	log.	14
long-distance		11
looker-on		11
lopsided		11
low-pressure*		4
low-priced*		4
low-speed*		4
lower feed-cone*		2
lukewarm		11
L (ell)		19
machinable		11
machine-made		11
machine rate		16
magnetos		11
make-and-break ignition		13
make-ready*		4
make-up*		4
management		16
mandrel		14
manhole		12
master plate		12
masterpiece		11
matter-of-fact		11
maximum	**max.**	14
mean horizontal candlepower	**m.h.cp.**	
mean lower hemispherical candlepower	**m.l.h.cp.**	
mean spherical candlepower	**m.s.cp.**	
metal drilling tools*		6
metal grinding tools*		6
metal turning tools*		6
metal-working machines*		6
millboard		11
milldam		11

millwright		11
miscellaneous	misc.	14
misfire		11
miter-box		12
modulus of elasticity in tension	E.	14
mold	not mould	11
moldboard		11
motor car		13
motorcyclist		11
motor-driven		11
mud drum		13
multi-phase		12
muzzle-loader		11
naphtha	not naptha	11
Napierian logarithm of	log	14
natural	nat.	14
National District Heating Association	Nat. Dist. Htg. Assn.	14
network		13
nickel	not nickle	11
nickel-plated		13
nom-de-plume		12
northeast		12
number	N (math. tables)	14
oftentimes		12
oil-bath		12
oil groove		13
oilstone		12
O.K., O.K'd, O.K.ing		11
one-half		12
opere citado (works cited)	op. cit.	11
orebody		15
organization		16
ounces	oz.	14
outside diameter	O. D.	14
over-all		12
overflow		13
overhead		16
oxid	not oxide	11
pack-harden		12
passageway		13
patternmaker		12
peak load		13

penstock		13
perpendicular	**perp.**	14
phone		11
phosphor-bronze		12
pincers	not pinchers	11
pipe tongs		13
pipe wrench		13
pitman rods		11
pitmen	not pitmens	11
planning division		16
plow	not plough	11
pocketbook		12
point	**pt.**	14
polyphase		12
porcelain		11
premium		16
pressure gage		13
prick-punch		12
Proceedings	**Proc.**	14
program		11
pump room		13
punch-holder		12
puppet valve	not poppet valve	11
push-rod		12
quarts	qt.	14
quod vide (for which see)	q. v.	11
rack-cutter		12
radius	rad.	14
railway-accident		13
rainfall		13
rarefy	not rarify	11
rawhide		12
rectangular	**rect.**	14
reenforced	(again put into effect)	11
reengage	not re-engage	11
reeve	not reave	11
reexhaust		11
reinforced	construction work	11
resin		11
right-hand		12
rosin		11
rough-grind		12
rough-turn		12

roundhouse		12
routing		16
safety valve		13
sandblast		12
sandpaper		13
saturated	sat.	14
sawed	not sawn	11
sawing machine*	not saw	6
sawtooth		12
scheduling		16
scrap-book		12
screwdriven		12
sea-island cotton		11
secant of	sec	14
hyperbolic secant of	sech	14
inverse hyperbolic secant of	$sech^{-1}$	14
second-feet	sec.-ft.	11
segment	segm.	14
selvege	not selvedge	11
set-up		12
sewage	(matter)	11
sewerage	(structure)	11
shaping machine*		6
sheave	not shieve	11
sheet iron		13
shellac		11
shellacked		11
shipbuilding		12
shunt-wound		13
shut-down*		7
sine of	sin	14
hyperbolic sine of	sinh	14
single-hearth*		4
single-phase*		9
single-shear steel*		1
siphon	not syphon	11
six-cylinder		13
skee	not ski	11
skilful		11
slaked	not slacked	11
slide-rest		12
slide-rule		12

slotting machine*		6
smokebox		12
smolder	not smoulder	11
Society of Automobile Engineers	S. A. E.	14
someone		12
specific gravity	sp. gr.	11
speed-box		12
spillway		13
spindle thrust-bearing*		2
standard	std.	14
Standard (British) wire gage	S.W.G.	14
standpipe		13
steadyrest		12
steam chest		13
steamship		12
sternpost		12
stockholder		13
stone-working machinery*		6
stop-gage		12
stop-screw		12
store room		13
store-room		12
stove-lid		12
stuffing-box		12
sulfur		11
sulfureted		11
sulfureting		11
superheater		12
surface elevation		13
switchboard		12
swivel-plate		12
system		16
tail race		15
tailstock base*		2
tailstock body*		2
take-up*		7
tangent of	tan	14
arc whose tangent is	$\tan^{-1}$	14
hyperbolic tangent of	tanh	14
temperature	temp.	14
templet	not template	11
tensile strength	T. S.	14
three-phase*		9

three-ply		13
thrust-bearing check nuts*		2
thumb-screw		12
thumb-tack		12
tidewater		13
time element		16
time study		16
tool-dresser		12
tool-holder		12
toolmaker		12
tool-rest		12
tool-room		13
T-rail		19
Transactions	Trans.	14
triple-expansion*		4
T-slot		12
tubesheet		12
tumbler-gear latch*		2
tumbler-gear segment*		2
turning machine*		6
turntable		12
two-by-six rafters		13
two-cycle		13
two-phase		12
twyer	not tuyere	11
tying	not tieing	11
typewriter		
typist		
ultimate	ult.	14
unaflow		
una-flow		
under-cut		12
uni-directional-flow		
uniflow		
uni-flow		
United States Standard	U.S.S.	14
updraft		17
vaseline		11
velocity	vel.	14
Venturi tube		11
versed sine of	vers	14
versus	v.	11
versus	vs.	14

vertical	vert.	14
very-slow-speed motor		18
videlicet	viz.	11
vise		11
vitreous		11
vitrify	not vitrefy	11
voltmeter*		9
volume	vol.	14
volumetric	volum.	14
wash-room		12
water-jacketed		13
waterproof		12
watershed		13
water wheel		15
wedge-shaped		13
weight	wt.	14
wheel base		15
wheel-base		12
wheel-spindle		12
windmill		12
wire-drawing		13
wood-working machines*		6
wool-working machinery*		6
wood-worker		12
work-bench		12
work-shop		12
work-spindle		12
work-table		12
worm-gear		12
worm-wheel		12
wrist plate		15
wrought	wr't	14
wrought iron	W. I.	14
X ray		11
year(s)	yr.	14

Miscellaneous.

⅝-inch pipe	11
ten 10-horsepower cars	11
12-inch main	11
14 inches*	3
16-candlepower	13
35-candlepower lamp	11

75-horsepower engine 11

1. From the report of committee 24, on uniform nomenclature of iron and steel, International Association of Testing Materials, Eighth Congress, New York, 1913. (Not accepted.)
2. Preferred names for lathe parts as determined by a ballot of builders of lathes. See *American Machinist*, April 24, 1913.
3. From the report of a committee to co-operate in standardizing abbreviations, symbols, punctuation, etc., in technical papers. *Proceedings of the American Society of Civil Engineers*, April, 1904 (Volume XXX, No. 4), pp. 174–177.
4. Taken from an old style sheet of the American Society of Mechanical Engineers.
5. From C. B. Going, editor, *The Engineering Magazine*.
6. Suggested by Mr. D. M. Wright.
7. From a list prepared by W. P. Cutter, librarian of the Engineering Societies. 29 W. 39th Street, New York.
8. A. I. E. E. standard abbreviations and notation, edition of February, 1913.
9. From Standardization Rules of the American Institute of Electrical Engineers. Edition of December 1, 1914.
10. Suggested by Mr. W. W. Crosby.
11. From the Style Book, a compilation of rules governing executive, congressional, and departmental printing, Washington, D. C., 1913.
12. A list of words approved by the editor of *Machinery*, Mr. F. L. Rogers.
13. From an article by Professor C. W. Park in the November, 1915, number of the BULLETIN, S. P. E. E., on "The Writing of Compound Technical Terms."
14. From a list of abbreviations prepared by Professor Lionel S. Marks for his new handbook.
15. Suggested by Professor Wm. D. Ennis.
16. Suggested by Professor Hugo Diemer.
17. Suggested by Professor E. B. Norris.
18. From a list prepared by Mr. C. M. Sames.
19. Suggested by Mr. Chas. Day.

It is suggested that members of the Society who are interested write to the Public Printer, Washington, D. C., for a copy of the Style Book. This prescribes the forms, spellings, hyphenatings, and abbreviations that must be followed in Government publications. The Style Book itself recognizes Webster's New International Dictionary, edition of 1910, as an

authority, from which it varies in certain specified cases. It is extremely likely that many of the forms given in the Style Book will be followed generally because of the fact that Government publication are often considered authoritative. There are some forms in the Style Book, however, that can be changed for the better in future editions.

The work connected with the preparation of this report has been too great to permit the consideration of uniform symbols for mechanics and hydraulics, as was suggested at the meeting of 1915.

Respectfully submitted,

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RESEARCH AS AN ELEMENT OF THE GROWTH AND PROGRESS OF THE SCHOOL.

BY P. F. WALKER,

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As developed in the minds of those who were determining the form of the discussion to be held at this time, the topic was divided among the following sub-heads:

(*a*) Research as a direct aid to teaching.

(*b*) Research as a means to keep instructors in condition of growth.

(*c*) Research for the intrinsic value of results.

(*d*) Research to make possible the efficient and economic utilization of laboratory equipment.

(*e*) What the institution should do in the matter.

It is the thought of the writer that when the above topic and outline has been set down, the opening paper for its presentation to the membership of the Society is fully written. Nothing more is truly necessary. The benefit to be derived will come from discussion by the many rather than by one or two, and it is proposed to make this opening discussion simply one among those which are expected to follow.

It is evident, of course, that we are considering the research possibilities and research functions of the school. As school men and would-be educators it is incumbent upon us to consider the ultimate purpose of the school and the means which contribute most effectively to the accomplishment of the ultimate purpose. Important as research is when viewed in the light of results in the advancement of knowledge and of the arts, the main purpose of the school is to teach. The strongest men obtainable are needed there and, once secured, the first concern of the institution should be to fix the conditions under which they may labor effectively and consistently. To be strong they must be growing men. It may be taken as axio-

matic that that policy of administration which fails to include in its program the fostering of those factors which minister to the growth of the teaching staff, is providing for a period of stagnation and decay. It may be that the conditions which make for growth and development for the one man will be impotent in the case of another, so there is no disposition at this time to argue for the commonly accepted forms of research topics and methods as a panacea for all ills; no intention of saying that every man on our engineering faculties must engage in formalized research along some technical line within his field. But at this time it is maintained that research is one of the elements which contributes to the desired result. If it be granted that many of our men in faculty positions are capable of directing and conducting investigations along technical lines, then the question is confessedly not an academic one but one which bears upon both school and industrial work in a very direct and special manner.

The four leading sub-heads listed above indicate the principal purposes for research in our established schools. The man who is meeting live students and discussing topics of engineering character which must be live themselves, has no easy task cut out for him, if he is to command the interest of all. Every condition and circumstance which lends interest and vitality is a distinct help. It is not enough that the instructor should read his magazines and keep up on current topics and other accomplishments in the field. Knowledge of his subject and all of the many personal characteristics of which we hear so much these days are necessary, each and every one, so that none may be omitted. A vital element in the process of teaching, however, is the attitude of the student which reflects in many ways the condition of mind of the instructor himself. The creation of interest and enthusiasm depends upon the extent to which the same elements are present in the teaching, and in the great majority of cases the possession of these calls for active participation in the advancement of the subject. In addition to these unconscious influences which pass between instructor and student there is a

positive factor present in the shape of the conscious recognition on the part of the student of the progressive spirit which impells his instructor to participate in progressive work. He knows, and gives full credit for it, that the man to whom he is looking for guidance and assistance is himself so thoroughly a master in his branch that work which the latter is doing is recognized abroad as well as at home. The double purpose indicated by the first two of the main topics is thus met in the case of those men who are so constituted that they are successful in research. The great majority of our faculty men are in this class.

A common fault, not peculiar to teachers of engineering but one to which all who think upon matters of scientific and industrial significance are liable, is the error of assumption of the infallibility of scientifically expressed results. The tendency to accept statements which are made by science workers as though these workers possessed some unusual and distinctive insight, is strong. People have generally seemed to feel that anyone who spoke in scientific terms and handled natural elements through the medium of scientific apparatus must of necessity have some special hold on a power to interpret the secrets of nature by processes which differed in some unexplainable way from methods employed by others who proceeded along other paths of reasoning.

As a matter of fact the history of the development of science is marked by the succeeding steps which the devoted workers have succeeded in taking. Thus in the realms of heat or light or electricity, theory after theory has been evolved, lived through its short day, and then passed on to be succeeded by the next member of the series. Each in its turn was entitled to respect because it seemed to explain the facts of life which were at the time foremost in the minds of the workers, and the man who has kept abreast of the situation is one who has taken these explanations at their face value and with a consciousness of possible limitations. It is only by the exercise of this spirit that we progress at all along lines of science or along lines of practical adaptation of scientific principles to industry.

The non-progressive man is the one who fails to catch the spirit which animates true research and this he does by reason of his mind being unoccupied with the world of cause and effect. His mind is remaining at rest on the established principles enumerated in his text-book and the end for him is at the beginning. A writer in a recent number of *Science* touches this point in these words:

"The only preventive force is the scientific spirit. It is a development of the quality or tendency of the mind which has compelled man in all the periods of his history to discard or to recast his truths because they do not work, and to accept new ones because they do work. That tendency in common life has operated crudely and slowly, it has caused countless mistakes and the temporary acceptance of countless errors, but it has brought us to our present stage of civilization. It is indeed nothing else than the pragmatic spirit. The scientific spirit is the pragmatic spirit trained in the strictest fashion to accept only what answers rigid tests and reinforced by an intense curiosity or desire to know. The very essence of this spirit is manifested in the habit of unceasing, relentless criticism. Without such incessant criticism there would be chaos in science. The scientific spirit, as thus understood, is an all-powerful factor in establishing scientific truth."

The man who is really imbued with this spirit goes before his class with an enthusiasm that is born of a fire which cannot be quenched. He works because he loves to work and the students who sit before him recognize that fact with an accuracy that is as keen and appreciative of power as it is deadly in detecting the formality of the copyist. Such a man is a teacher in the truest sense of the term and if he is produced once in a decade by the expenditure of whatever is necessary in order to provide him with the means for the exercise of his active mind, the expenditure is warranted a thousand times over. That research can do this, and that for many men it is the only agency through which expression of force and genius is possible, is a fact so well known that it need not be repeated.

There is little necessity to enlarge here upon the intrinsic

value of that which is accomplished through the medium of the laboratory. Before the people of the country at large, however, there may be reason for such an argument. Another writer has this to say at this point, while addressing a recent gathering:

"I want you to realize that in America we are going ahead in the future at a rate dependent entirely upon our preparation. Laboratories are a relatively modern thing. In most of the sciences they are a development within the lives of men now living. I want you to see that we must be foremost in systematic, organized research, or we will be distanced by other countries which already well recognize the value of new knowledge.

"When so much of our material welfare, the condition and extent of our manufactures, the quality of our agricultural efforts, and the health of our people, depend upon the rate of our acquirement of new knowledge, there ought to be much greater effort made along the lines of research than is at present the case."

To accomplish all this there are two well-recognized methods of procedure. The one is to employ for the work, associating them with laboratories, which, we may say, are employed for school work, men whose only duty it is to engage in lines of investigation. The other method is that of carrying it on through men who come daily into contact with students in the class room, freeing them from drudgery so as to make possible the application of their time and energy to the desired results. From what has proceeded it is not difficult to conclude that in the mind of the writer nearly every argument turns in favor of the latter procedure. Under appropriate conditions which are readily realized, results of full value are procurable and at the same time there will be possible that other development which is so essential to the efficient teacher. Too often the question is argued and decided upon the basis of the one element of financial efficiency in results and thereby a most vivid example given of reasoning by methods which are the reverse of scientific. To arrive at the true conclusion every advantage

and every item in the stream of results which flow from such a source must be considered. Here, as in other lines of science, the administrator and the student of educational policies must possess the spirit of willingness to accept principles if they work and to discount them if they do not work. There is no lack of instances to show that the opening up of opportunities for the exercise of the creative spirit and genius of the teacher has resulted in a total effect which embodied the double result just indicated. Important investigational results have been accomplished by men whose lives have been devoted to the cause of education and who have become great teachers through their work.

After all, there may arise the question of what is research and what may be the other classes of activity which will bring the opportunity and the results to those who may not be adapted to research of our stereotyped forms. For some it is investigation in its purest meaning. For others it is the opportunity for participation in the active affairs of industry, be it construction, public utilities service, or what not. For some it may be that intensive devotion to study and service which results in the writing of books. A well-known publisher, but recently deceased, is credited with a remark that no college professor is satisfied until he has written at least one book. May it not be true that such a condition is the result of the limitations which have been cast about so many educators and which have compelled them to find an outlet for their energies by doing that one thing for which so many are unfitted? May not the genuine be attained if conditions are such that those who may best investigate, investigate; that those who best may practice their profession in the community industrialism, so participate; and that those who best may write, write books?

Have administrators of institutions devoted to science exercised the scientific spirit in deciding these problems, is a fair question. It may be assumed that schools of this type touch the industrial life of the region. This is particularly the opportunity for those connected with the publicly supported

schools, such as our state universities. For such, the question of results measured in terms of commerce and industry is a pressing question, but no less pressing is that other one of the need of effective handling of the human stream of student life which flows past him. No less real, let us add, is the justice of the idea that it is a matter of concern for school executives to recognize the good of that other less rapidly flowing stream of instructors, the workers on which the real burden falls. In the main these administrators are of scientific and technical training, and by them should the strict analysis of all influencing conditions be made. In this, no more than in the other affairs which make up the busy life of the world, should we expect that the one conclusion will hold for all, but in many cases it is evident that the true conclusion will be that research performs its greatest function, and makes possible the most complete utilization of available equipment, when it is being adjusted to meet the needs, and furnishes the outlet for the ambitions, of the men who are moulding the lives of students by daily contact in the class rooms.

OCCUPATION AND DISTRIBUTION OF GRADUATES FROM ENGINEERING COLLEGES.

BY A. A. POTTER,

Dean of the Division of Engineering, Kansas State Agricultural College,

and

M. R. BOWERMAN,

Instructor in Machine Design, Kansas State Agricultural College.

Statements are often made that only a relatively small per cent. of graduates from engineering schools remain in engineering work. In order to verify this statement, a study was made of the occupations of alumni from over fifty representative engineering colleges in the United States. The results incorporated in this paper include graduates from classes 1901 to 1914 inclusive.

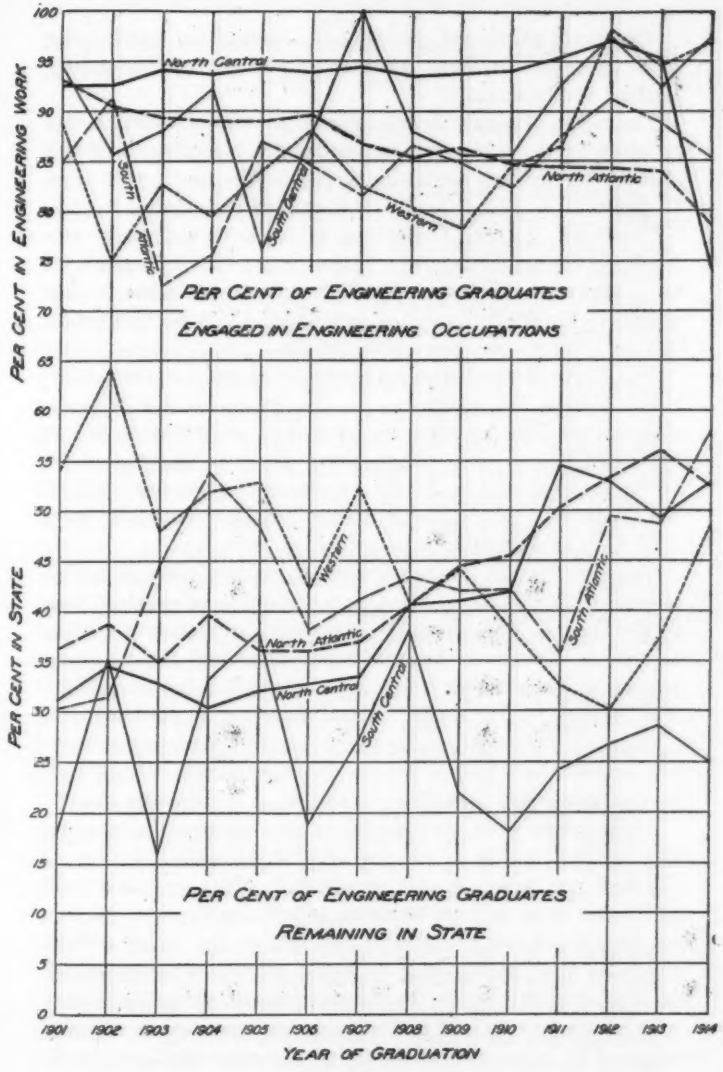
The records and percentages are compiled from 22,697 graduates whose occupation and residence was definitely known. Under engineering as occupation are included: practicing engineers, engineering draftsmen and designers, construction engineers, engineering salesman, teachers of engineering or of allied subjects, and engineering executives.

The institutions investigated and their locations are shown in the accompanying table.

In making this investigation, it was found that several of the leading engineering colleges kept no record of their alumni. Such records, if carefully kept up to date, should prove of great value to engineering education.

Percentages of Graduates Remaining in Engineering Occupations.

This investigation proves conclusively that 90.1 per cent. of graduates from the engineering schools of the United States remain in the occupations for which they were prepared.


PER CENT IN ENGINEERING WORK
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
North Central
South Atlantic
South Central
Western
North Atlantic
PER CENT OF ENGINEERING GRADUATES
ENGAGED IN ENGINEERING OCCUPATIONS
PER CENT IN STATE
Western
North Atlantic
South Atlantic
North Central
South Central
PER CENT OF ENGINEERING GRADUATES
REMAINING IN STATE
1901
1902
1903
1904
1905
1906
1907
1908
1909
1910
1911
1912
1913
1914
YEAR OF GRADUATION

The chart shows the percentages engaged in engineering work of graduates from engineering colleges in the various sections of this country.

The North Atlantic Group, which includes the institutions as given in the table, and represents 8,452 graduates, shows that the percentages remaining in engineering work vary from 79 per cent. to 93 per cent. The average percentage is 87.

The South Atlantic States (see table) show a greater variation, the limits varying from 72 per cent. to 92 per cent., with an average of 85 per cent. This greater variation is due mainly to the small number of graduates, which for this group is only 1,382 for the years 1901 to 1914.

The North Central Group (see table) shows the least variation. Taking the graduates in this group of the thirteen classes from 1901 to 1913, the variations are between 92 per cent. and 97 per cent. This group which is represented by 16 institutions and by 11,444 graduates, has 94 per cent. of the students who graduated during the thirteen years from 1901 to 1913 remaining in engineering work.

The variation in the South Central institutions (see table) is greater than in the North Central, the figures varying from 76 per cent. to 100 per cent. The general variation is similar to that in the South Atlantic institutions and for the same reason, which is a relatively small number of graduates, 725. The average for the South Central Group is 90 per cent.

Eighty-six per cent. of the graduates from western engineering schools (see table) remain in engineering occupations. In this group 694 alumni are included in the investigation.

There seems to be no definite relation between the occupation and the number of years after graduation from college, if the first two years are not considered. The occupations of graduates from any professional school during the first two or three years are of little importance, as the young college graduate must find himself by actual contact with the world. It is most gratifying to the engineering schools to know that over ninety per cent. of graduates in engineering are actually engaged in engineering occupations. Similar studies of grad-

uates from law and from medical colleges should prove of much interest.

Distribution of Graduates in Engineering.

While making the investigation relative to the occupation of engineering graduates, a study was also made of the number of engineering graduates who remain in the state where the institution graduating them is located. This information is often asked graduates, a study was also made of the number of engineering graduates who remain in the state where the institution graduating them is located. This information is often asked for by legislators or executives at the head of state institutions. There is little argument against the fact that the main purpose of any state government is to aid in bettering the conditions of their citizens, irrespective of whether such citizens remain in the state or move to some other state. Many of our leading institutions of learning are devoting large sums of money to the education of people not only outside of the particular state where the institution is located, but also for the training of students from many foreign countries. Altruism must go hand in hand with education and it is only by such breadth of view that any college or university can best serve its purpose.

A study of the engineering graduates from the institutions as given in table (see chart) shows that 41.1 per cent. remain in the state in which they were educated for the engineering profession.

The northern and western groups of institutions retain a larger percentage of their graduates than do the southern states. This is to be expected on account of the development of the manufacturing and other engineering industries in the northern and western sections.

In the North Atlantic Section, 53 per cent. of the class of 1914 remained in the state, 46 per cent. of the class of 1910, 37 per cent. of the class of 1907, 35 per cent. of the class of 1903 and 36 per cent. of the class of 1901. An average of 42 per cent. of the graduates from institutions located in the

North Central states remain in the state in which they were educated.

The South Atlantic Group shows 58 per cent. for the 1914 class, 42 per cent. for the 1910 class, 41 per cent. for the 1907 class, and 30 per cent. for the class of 1901. An average of 44 per cent. remain in the state where the institution from which they graduated is located.

The North Central Group shows 53 per cent. for graduates of 1914, 42 per cent. for 1910, 34 per cent. for 1907 and 31 per cent. for 1901. The average for this group, remaining in the state is 41 per cent.

The South Central institutions have 25 per cent. of the 1914 class, 18 per cent. of the 1910 class, 27 per cent. of the 1907 class, and 18 per cent. of the 1901 class, remaining in the state. In general the average is 27 per cent. with little indication as to the relation between the numbers remaining in the state and the years engaged in the profession.

The Western States show an average of 43 per cent. as remaining in the state.

In general, there is little difference in the percentages of graduates remaining in the state after graduation from engineering colleges in the various sections of the country. The nature of the engineering profession often requires frequent change of position. This is particularly true in the case of civil engineering graduates.

In addition to these figures by classes, corresponding data for the total graduates of several years was obtained from several engineering colleges:

Of the graduates from the University of Missouri, classes of 1908–1913 inclusive, about 90 per cent. are engaged in engineering and 60 per cent. are now in the state of Missouri.

The Agricultural and Mechanical College of Texas gives for the classes of 1900–1915 inclusive, as 82 per cent. now engaged in engineering and 67 per cent. in the state of Texas.

University of Washington (Seattle), for graduates during the period 1901–1915 inclusive, 85 per cent. as now engaged in engineering and 66 per cent. in the state of Washington.

University of Vermont, classes 1901–1915 inclusive, 90.4 per cent. engaged in engineering and 20.2 per cent. in the state of Vermont. Of the graduates during the past five years, 33 per cent. are still in Vermont.

University of Maine, of the graduates during the past ten or fifteen years, at least 95 per cent. are engaged in engineering. Of classes previous to 1910, 26 per cent. are in the state of Maine; and since 1910, 29 per cent. are in the state.

North Dakota Agricultural College, gives 85 per cent. engaged in engineering and 41 per cent. in the state of North Dakota.

Vanderbilt University has about 87 per cent. of its alumni in engineering work.

In this miscellaneous group, some of the advantages in engineering work were given directly by the institution. Hence, they were probably not all computed on the same basis. In general, the averages compare favorably with the averages of the other institutions investigated, and aid in showing that the engineering colleges of the United States prepare their graduates for active work in the industries.

Location of Institutions Investigated.

Group I—North Atlantic.

Carnegie Institute of Technology,
Clarkson College of Technology,
Columbia University,
Lehigh University,
Massachusetts Institute of Technology,
New Hampshire State College,
Pennsylvania State College,
Pennsylvania University,
Rhode Island State College,
Rutgers College,
Stevens Institute of Technology,
Tufts College,
University of Pittsburgh,
Vermont University,
Worcester Polytechnic Institute.

Group II—South Atlantic.

Clemson Agricultural College,
Delaware College,
Georgia School of Technology,
North Carolina A. & M. College,
University of Florida,
Virginia Polytechnic Institute,
West Virginia University.

Group III—North Central.

Armour Institute of Technology,
Case School of Applied Science,
Iowa State College,
Iowa State University,
Kansas State Agricultural College,
Kansas University,

Michigan Agricultural College,
Michigan University,
Minnesota University,
Ohio State University,
Purdue University,
Rose Polytechnic Institute,
South Dakota State College,
University of Illinois,
University of Wisconsin,
Washington University (St. Louis).

Group IV—South Central.

Oklahoma A. & M. College,
University of Arkansas,
University of Kentucky,
University of Tennessee.

Group V—Western.

Colorado University,
Idaho University,
Nevada University.

A PLEA FOR THE FURTHER STUDY OF EFFICIENT METHODS IN THE ADMINISTRATION OF AN ENGINEERING COLLEGE.

BY C. C. MORRIS,

Assistant to the Dean, The Ohio State University.

The purpose of this paper is to call attention to the need of further systematic study of efficient methods of administration in engineering colleges. Reference is not made to the larger problems of policy and control which must be met and solved by the dean. Those problems are in mind which must be met by the one in charge of the details of the office work. Problems involving the preparation of teachers of engineering, their summer employment, the time to be spent by them in work outside of their regular class work, the relation of the engineering college to the university of which it is an integral part, are all problems for the dean. But how best to prepare for the student a suitable schedule, how to keep in constant touch with him, how to help him when he needs help, to lighten his load if it is too heavy, how best to keep him in line when he begins to waver, how best to find out if he is, or if he is not, fitted for the work of an engineer, these are the tasks of the one who is assisting the dean. All this work requires machinery, and this machinery may be efficient or it may be inefficient. So far as the writer knows, there is no place where an inexperienced assistant may go to find out what methods have been successful. When the writer was appointed to his present position, he very naturally was anxious to find out all he could about the duties of his office. He was surprised to find that literature upon the subject was practically nonexistent. This paper is the result of his efforts to work out his own salvation. As progress has been made, the thought suggested itself that it would be a good plan to gather to-

gether in one pamphlet all the best methods of procedure of the various colleges.

In an effort to find out how other institutions were carrying on their office work, a trip to several of the larger institutions was made. In each, one or more methods were found which had been tried out and found particularly efficient. In one institution, that particular phase of the work to which special attention had been given, showed marked development. In another institution, an entirely different phase had been worked out and developed. There is no doubt but that every institution has something, either a detail of organization or some efficient plan of dealing with students that every other institution would profit by knowing. That there is a great variety of methods of various degrees of efficiency and inefficiency is apparent even to the casual observer, and that there is a large field here which should be carefully worked over is evident.

This is suggested, not with the thought that any institution might want to adopt in toto any method or device used by another institution, but with the hope that each would be able to find something worth working over and adapting to its own local needs.

The writer is fully aware of the fact that there are many details of office work in which a large majority of the members of this society are not in the least interested, yet in every engineering college there are two or three that are vitally interested in everything that tends to facilitate the task of dealing with students, and to lighten the load of the administrative officers.

The methods of administration of each college are more or less the result of local conditions and are directly affected by those of the university of which it is a part. Their growth has taken place in a haphazard sort of way and has been largely due to chance. This may be explained by the fact that not until recently has the dignity and importance of the work been realized. In the past there has been a secretary of the college who regarded his office duties as secondary to his

teaching duties. As soon as his conscience allowed him to do so, he passed on his secretarial work to someone else and returned to his teaching. The office was thought of only as a temporary abiding place and not worth his best efforts. It is evident, however, that the work is now coming into its own, and it is demanding the best efforts of able men. The assistant to the dean is in the majority of cases a man of full professorial rank, and often the head of a non-technical department.

One of the most troublesome questions that occupies the attention of the administrative officers is that of schedule making. At The Ohio State University there is a system of preregistration. During the summer vacation, there is prepared by the assistant to the dean a schedule for each student. These cards are made out in triplicate, one for the student, one for the registrar, and one for the dean. Then, after they have been sent to the registrar's office and scored, the student's card together with his fee card is sent to him by mail. The fees are paid by mail and the student is ready for class work before the opening of the semester. There are some very serious objections to this plan. The schedules are made without a conference with the student. He may have plans unknown to the schedule-maker, for making up back work, or, if the student is dependent upon his own resources, it may be absolutely necessary to take into account the time which must be spent in outside work. This makes necessary a considerable number of changes and a large number of enrollment cards, prepared in the registrar's office when the original schedule was scored, are of no value. A great deal of this confusion could be avoided if it were possible to have the schedule bulletin completed by the first of March preceding the school year. Opportunity would then be given for interviews and the student's wishes could be taken into account. As a conservative estimate, I would say that thirty per cent. of the students of our college of engineering are to a greater or less extent dependent upon their own resources. How to plan the schedule-making so that these deserving men will get ade-

quate attention, yet at the same time to save the whole scheme of registration from utterly breaking down is indeed a difficult problem. The plan outlined above has many advantages. The responsibility is centralized. The one in charge of the work is supposed to be an expert in making combination of hours. He is conversant with the prerequisites of all the courses and he must see that these are met. If the student becomes irregular on account of "conditions" or "failures," he must see to it that those subjects around which his whole course has been built go on his class card. Otherwise, as has often been the case, the student will find himself in the position of being ineligible to a full schedule. He must see that the cards are cleared as the student goes forward and that no subject is left behind. He must see that all requirements for graduation are being met. As he works, he must keep in close touch with the score sheet in order that the balance of the sections may be maintained. All these duties may be done best by one central authority. This plan, so far as I know, is not followed by any other engineering college. Usually there is a committee on schedules made up of the heads of departments which meets with the students on registration day. The students are grouped according to their classification and the committee aided by members of their respective departments spend a day or two making schedules. Often as high as fifty or sixty are working at the same time. The offices are crowded to the limit and long lines of men spend hours awaiting their turn. Confusion is everywhere. Some men take their task conscientiously, others hurry them through. Since the art of schedule-making is one that can only be learned by experience, a great many unbalanced schedules must result. Again, it is difficult to get men who are heads of departments and who are busy with outside activities to take proper interest in a work which they regard as more or less routine in character. The advantages of a schedule committee are, however, self-evident. Each student has the opportunity to talk over his plans and purposes. He comes in rather close contact with

men of his own department, and often acquaintanceships formed under such circumstances are of great value to him.

Another question to which the writer has given much thought is this: how far can one go in putting the student upon his own resources. Some colleges make for him in an arbitrary way his schedule, keep track of every absence, solicit from his instructors reports as to his scholarship at frequent intervals, and in every way treat him as one devoid of initiative of every kind, and unable to attend to his own affairs. The college is indeed both father and mother to him. The student is deprived of the responsibility of making his own choices, of planning his own work and developing himself along the line of self-reliance. It is the opinion of the writer that administrative officers must after all remember that the boy, not the machinery of the administration, is the important factor. Where to draw the line between that for which the student may be held responsible and that for which the office may be held responsible, so that the student may have the greatest possible freedom, and so that the dignity and effectiveness of the administration may be preserved is a problem of great importance.

I have mentioned two subjects which should be carefully considered. There are many others that are worthy of study by a committee made up of those who are engaged in administration of what might be called the student side of the college and it is the suggestion of this paper that either one of the committees now in existence be asked to do this or that a new committee be created for the purpose.

ENGINEERING EDUCATION AND COÖPERATION AMONG ENGINEERS.*

BY JOHN F. HAYFORD,

Director, College of Engineering, Northwestern University.

The Society for the Promotion of Engineering Education is vitally interested in the improvement in the profession of engineering which would be produced by closer coöperation among the very numerous engineering societies.

There are strong interests which the many engineering societies have in common. They should coöperate for those interests. The activities of the various engineering societies are largely confined to technical engineering matters. In placing strong emphasis on these, many less technical matters which are important to engineers have been largely overlooked, and these are largely matters of common interest to the whole profession.

In these matters the teachers of engineering are as much concerned as those who are in engineering practise. There is no clear line of distinction between the two groups. The teachers of engineering are in many engineering societies. Their problems overlap and agree in many particulars with those of the practising engineers, especially in all problems of the relations between men, the training of men, and the selection of men for particular projects. The teacher of engineering takes certain men from the high schools and selects, trains, and develops them to the best of his ability for four or five years. The graduates then go out into the engineering work of the world. Those in executive control of engineering work then find that one of their most difficult and important tasks is to continue for thirty or forty years the training and development which was carried forward a few steps in college.

Coöperation among engineers would bring broader views and greater opportunity. These in turn would bring corresponding improvements in the methods of teaching in engineering and in the opportunities of colleges of engineering.

* Read before the Conference on Engineering Coöperation, in Chicago, April 13th, 1916.

Engineers are too prone to become so interested in, and busy with, the details of their daily regular work that it is difficult to get them to look at the broader, higher things which concern them. Similarly the student is so busy with particular problems, with certain pages of certain text books, and so interested, that it is difficult to get him to look up. The problem of bringing about broader views, producing a vision of the greater opportunities, is very similar in the two cases.

With more coöperation and broader outlook among engineers there would be sure to come more emphasis on character and judgment, and ability to deal with men, as essential to engineering success. The corresponding improvement in education would follow promptly.

I am confirmed in my belief that a broader outlook on the part of engineers would lead to improvement in what they would demand from the teachers of engineering, when I picture in retrospect such demands as have been made in the past. It is my experience that when recent graduates are asked for suggestions for improvement in a college of engineering they usually suggest more narrow technical training, more information. It is equally true that when engineers of long experience, especially in positions where they have dealt with many engineers, are asked for suggestions, they advocate more general training, more emphasis on the quality of teaching, and more development of right habits of thought and action.

I feel confident that you may depend upon the Society for the Promotion of Engineering Education to be cordial toward coöperation. That is the habit of the society and of its members. Teachers of engineering are in the habit of keeping closely in touch with engineers and with engineering work. The Society for the Promotion of Engineering Education, organized for the purpose indicated by its name, has always welcomed practising engineers in its membership and on its program. More than one tenth of its present membership are men engaged actively in the practise of engineering.

THE MEANING OF INTEGRATION IN CALCULUS.

BY JAMES E. BOYD,

Professor of Mechanics, The Ohio State University.

The Society for the Promotion of Engineering Education has recently given considerable attention to the fundamental notions of calculus. At the Princeton meeting several papers were presented and the lively discussion which followed showed the interest in the subject.

Some writers insist that dy and dx never represent quantities and that dy/dx is not a fraction but merely a single expression for the limit of a ratio. This point of view is convenient in differential calculus but is sometimes so applied as to introduce needless confusion into the integral. In the applications of integral calculus it is necessary to form expressions for the increments of the physical or geometrical quantities involved. These expressions must represent something which may be visualized, and require the use of differentials. In making the connection between these expressions and the definite integrals some writers are not consistent; they define dy and dx as not representing quantity and then proceed to use them as differentials. Some are more careful, employing Δy and Δx for finite differentials and defining the integral sign and the final dx in $\int f'(x)dx$ as together constituting a single symbol for the operation of finding the function of x whose first derivative is $f'(x)$. No objection can be made to the logic of this method. It is not easy for the beginner to grasp or to connect with the idea of integration as a summation. Some writers of applied mathematics use it consistently, always expressing the increment by means of the finite differential and discussing the conditions as this differential approaches zero as a limit. Considered as an exercise in integration, a little of this process of practically deriving the principles of calculus each time a problem is solved

may be helpful to the beginner, but as a method of working out applied mathematics it puts too much emphasis on the machinery of the solution, distracts the attention from the physical problem, and is wearisome to the reader.

A second group of writers define dy and dx as representing very small quantities. This form of definition makes it easy to understand integration as a summation, giving a result which is approximately correct. To account for the fact that the results of integration are not approximate but are absolutely correct it is supposed to be necessary to define these differentials as infinitesimally small. The nature of some of these definitions is well illustrated by the examples given by Professor Huntington in his paper before the Princeton meeting.

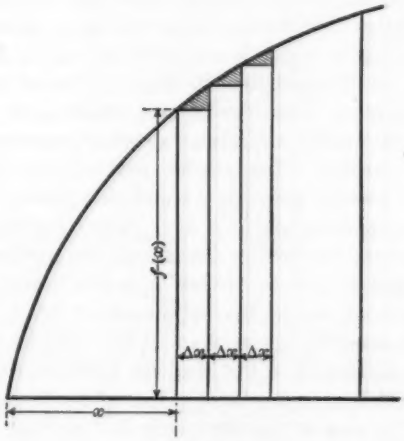


FIG. 1.

In taking up the definite integral it is customary to begin from the standpoint of the determination of an area. This area (Fig. 1) is divided into rectangles of height $f(x)$ and width Δx and the total area is said to be approximately equal to the sum of these rectangles. This total area is represented

algebraically by $\Sigma f(x)\Delta x$. The small shaded spaces of Fig. 1 show the difference between this approximate total area and the true area below the curve. As Δx is made smaller the number of these residue spaces is increased but their total area is diminished; and at the limit, when Δx becomes dx, the residue is said to vanish and the exact area is represented by $\int f(x)dx$. Various devices are used to show that the residue actually does vanish and that integration regarded as a summation is equivalent to the inverse of differentiation.

It is not at all necessary that the differential should be infinitesimal in order to make the results of integration correct. The differential (Δx) may be relatively large without any residue whatever. This is because the terms containing Δx^2 and the higher powers of Δx (frequently called differentials of the second and higher *orders*) have been discarded in deriving the rules for differentiation, and these terms represent exactly the residue which is not accounted for in forming the expression for integration. In Fig. 1, $f(x)\Delta x$ is the term which contains Δx in the first degree, while terms which contain Δx in the second and higher degrees represent precisely the shaded residue. The greater part of this residue is a triangle the base of which is Δx and the altitude the second term of the expansion of $f(x+\Delta x)$. The third term is equivalent to the area enclosed by the X axis, the parabola $y=kx^2$ and the ordinate $x=\Delta x$, where k is the coefficient of the second power of Δx in the expansion of $f(x\times\Delta x)$. The fourth term is equivalent to the area bounded by the X axis, the cubical parabola $y=k'x^3$, and the ordinate $x=\Delta x$ where k' is the coefficient of the third power of Δx in the above expansion. The area of the third term is $(k\Delta x^3)/3$, that of the fourth one is $(k'\Delta x^4)/4$ and so on.

When we consider $\int xdx=x^2/2$ we are accustomed to think that $x^2/2$ is the sum of a great number of terms of the form of xdx; it may as well be regarded as the sum of one or more terms of the form $x\Delta x+(\Delta x^2/2)$.

To justify these statements and illustrate their meaning we

will now consider a few simple examples, but before doing this it is advisable to *define* one term which we will use and to state the meaning which we propose to give to two common expressions of calculus.

The complete differential of a function is the entire increment of the function. The complete differential of x^3 is $3x^2\Delta x + 3x\Delta x^2 + \Delta x^3$.

The differential coefficient is the coefficient of the first power of Δx in the complete differential.

The integral of $f'(x)\Delta x$ is that function of x for which $f'(x)$ is the coefficient of the first power of Δx in the complete differential.

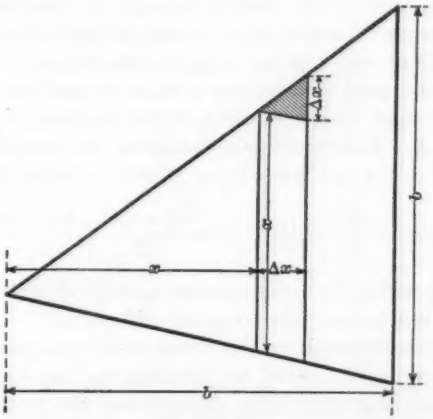


FIG. 2.

These definitions require no change in the methods of integration but merely give a different interpretation to the operation. In many cases integration is a mere algebraic process. Important applications can be made which involve in no way the ideas of limits or infinitesimals, and many more can be made which require the use of the limit of an infinite series but do not require that the differentials be regarded as infinitesimal.

Fig. 2 is a triangle of which the base is equal to the altitude. We will find the area, taking the vertex as the origin and the X axis perpendicular to the base. An element is made up of the parallelogram of area $x\Delta x$ and the shaded triangle of base and altitude Δx which is similar to the entire triangle and to the triangle of base and altitude x. If A represents area

$$A = \int x\Delta x.$$

We recognize $x\Delta x$ as a quantity of the second degree and as the first term of the complete differential of $x^2/2$. Expanding $(x+\Delta x)^2/2$ we find the complete differential to be $x\Delta x + (\Delta x^2/2)$. If the area of the triangle of base and altitude x is $x^2/2$, the area of the similar triangle of base and altitude Δx must be $\Delta x^2/2$ so that there is exact correspondence between the element of area and the complete differential.

To find the area between two lines $x=a$ and $x=b$ we may substitute these values as limits in the integral $x^2/2$ and get $(b^2-a^2)/2$. Instead of using limits in the integral we may substitute $x=a$ and $\Delta x=b-a$ in the complete differential.

$$x\Delta x + \frac{\Delta x^2}{2} = a(b-a) = \frac{(b-a)^2}{2} = \frac{b^2-a^2}{2}.$$

If we let $x=0$ and $x=b$ we get the area of the entire triangle from the last term of the complete differential.

Having determined the first term of the complete differential from the geometry of the problem the last term may be obtained without getting the integral and the area calculated without any use of integration.

Another example is that of finding the moment of the triangle of Fig. 2 with respect to an axis through the vertex parallel to the base. The moment of the parallelogram is its area $x\Delta x$ multiplied by distance $x+(\Delta x/2)$ and that of the shaded triangle is the product of $\Delta x^2/2$ multiplied by $x+c\Delta x$, where c is the ratio of the distance of the center of gravity from the vertex to the length of the median. The term which contains Δx in the first degree is the one obtained by multiply-

ing the area of the parallelogram by x. This is $x^2\Delta x$ and is recognized as the first term of the complete differential of $x^3/3$. The complete differential is $x^2\Delta x + x\Delta x^2 + (\Delta x^3/3)$. The entire moment is $x^2\Delta x + x\Delta x^2 + (c\Delta x^3/2)$ which corresponds exactly with the complete differential provided $c = \frac{2}{3}$. If the moment of the triangle of height x is $x^3/3$ its center of gravity is at the distance $\frac{2}{3}x$ from the vertex making $c = \frac{2}{3}$ for this triangle; it must have the same value in the similar small triangle, and the correspondence is exact throughout.

Instead of the first term of the complete differential we might get the second term and deduce the integral or the complete differential from it.

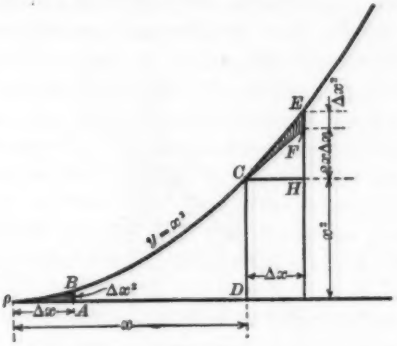


FIG. 3.

Fig. 3 represents the integral of $x^2\Delta x$ in another form—this time as an area. The ordinate at the left of an element of area is x^2 and that at the right is $(x + \Delta x)^2 = x^2 + 2x\Delta x + \Delta x^2$. The first term of the complete differential is the rectangle of area $x^2\Delta x$ from which the integral is seen to be $x^3/3$ and the complete differential is $x^2\Delta x + x\Delta x^2 + (\Delta x^3/3)$. The second term of the complete differential represents the triangle of base Δx and altitude $2x\Delta x$, this altitude being the first term of the complete differential of x^2. The third term must represent the shaded space *CEF* if we are to have exact

correspondence between the complete differential and the entire element of area. The shaded space *CEF* is equal to *PBA*, since the horizontal distance *CH* is equal to *PA* (both being equal to Δx), and the length of the vertical elements at any given horizontal distance from the vertex is the same for both (being Δx^2). If, then, the area of *PCD* is $x^3/3$ the area of *PBA* and of the equal *CEF* must be $\Delta x^3/3$ and the correspondence is exact.

This method may be continued for all functions of the form of x^n where n is a positive integer, and the integration of these functions shown to be merely an algebraic process. The differential may be of any size. Instead of integrating between limits, the complete differential may be written from the form of the first term and the result calculated by substituting the values of x and Δx.

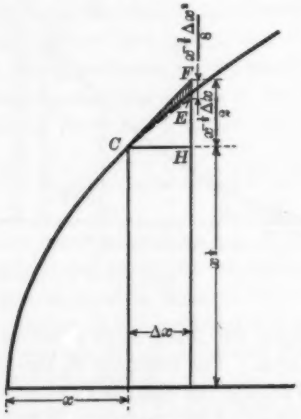


FIG. 4.

Fig. 4 represents the integral of $x^{\frac{1}{2}}x$. The second term of the element of area is the triangle of base Δx, altitude $x^{\frac{1}{2}}\Delta x/2$, and area $x^{\frac{1}{2}}\Delta x^2/4$. The altitude of this triangle is the first term of the complete differential of $x^{\frac{1}{2}}$. The third term of the element of area is the shaded figure *CFE*, the vertical

height of which, measured from the line CF, is $-x^{-\frac{1}{2}}\Delta x^2/8$, the second term of the complete differential of $x^{\frac{1}{2}}$. The area of CFE is the product of $-x^{-\frac{1}{2}}/8$ multiplied by the area enclosed by the curve $y=x^2$, the X axis, and the ordinate $x=\Delta x$. This area is equivalent to that of PBA (Fig. 3), and is $\Delta x^3/3$, so that the area of CFE is $-x^{-\frac{1}{2}}\Delta x^3/24$. In a similar way the next term of the element of area is found to be $+x^{-\frac{3}{2}}\Delta x^4/64$. From the first term the integral is recognized to be $\frac{2}{3}x^{\frac{3}{2}}$, the complete differential of which corresponds exactly with the element of area.

When the complete differential is an infinite series, as in this case, the area between any two ordinates may still be computed to any desired accuracy provided the ratio of Δx to x be such that the series is convergent. It is not necessary that the differential of x shall be infinitesimal unless x is infinitely small. (In the problem above, the entire area, from $x=0$ to any ordinate, may be calculated from the complete differential using $\Delta x=-x$. The series converges, but very slowly.)

As a check on the integral the element of area may be taken parallel to the X axis, giving the integral of $y^2\Delta y$, so that the student may see that even when the complete differential is an infinite series, exact results may be obtained by the use of finite elements.

Any problem involving integration between limits may be solved in the usual way, or the value may be calculated with finite increments. When the complete differential has a limited number of terms the results of the two methods agree exactly. When it is an infinite series they may be shown to agree to any desired degree of accuracy.

The complete differential may be determined by the methods used in the preceding problems or by Taylor's theorem. It may be employed, instead of the ordinary integration, in the solution of many important applications of mathematics, such, for instance, as the derivation of the equation of the elastic line of a beam or column. The results of the use of the complete differential are frequently easier to interpret than those secured by integration.

A few simple examples like these should be sufficient to show to the student that differentials need not be infinitesimal in order that the results of integration may be correct, but that the troublesome residues are fully accounted for by the terms of the complete differential which are usually discarded. They are not presented as substitutes for the ordinary methods of integration, but merely as side lights which may help to clear up some of the confusion which seems to exist in regard to this subject, and show that differentials are finite realities, and not mere "ghosts of departed quantities."

IS ENGINEERING EDUCATION EFFECTIVE?

BY A. B. McDANIEL.

Assistant Professor of Civil Engineering, University of Illinois.

"I do not care what degrees an applicant may have or what school he is a graduate of; these facts do not influence me any more than any other qualifications." Thus recently spoke a large employer of technically trained men and a graduate of a well-known technical school of a generation ago. This point of view has been lately corroborated by several of the leading engineers of the country. An eminent engineering educator and consulting engineer states: "Personally, I can truthfully say that a college degree, even an engineering degree, does not count for anything with me. If I were hiring a man I would pay no attention simply to the college degree, but would make further inquiry and depend upon that just as I would in case a man came to me with other credentials." These statements furnish food for thought and at least indicate an opinion which seems to obtain somewhat among the members of the engineering profession. If such an opinion is correct and just, does it not indicate an unfortunate condition of affairs? *Is engineering education effective.* To answer these questions let us give consideration to some phases of engineering education.

What Engineering Education Should Accomplish.

Engineering education should train young men to be self-reliant, resourceful and forceful, to serve faithfully and obediently; and to take a real part in the world's work. The *sine qua non* of education should be the training of minds and not the imparting of knowledge. That our present system of instruction is not successful in producing the desired training is indicated by the general criticism of our product, the average technical school graduate. Why does the young grad-

uate generally lack initiative, force, ginger, and a willingness to start at the bottom and work hard?

TEACHERS SHOULD BE DYNAMOS OF EDUCATIONAL POWER.

The coach of a squad of athletes does not train his men for a field-meet by pushing them around the track in wheel chairs; yet throughout our educational system in this country, the students are helped and nursed along the path of knowledge until upon graduation from college they are mental weaklings. This is exemplified by the "express it in your own way, my dear" method of teaching which is so prevalent in our secondary schools. What our schools need most at the present day are real, virile instructors, men of thorough training, large ideals and great enthusiasm. Too many teachers are splendid storage batteries of knowledge, but lack the generating force of the dynamo. The late Senator George F. Hoar, in his autobiography, eulogizes the teachers of a former generation in these words:

"Making all the allowance for the point of view, and that I was then a youth looking at my elders who had become famous, and that I am now looking, as an old man, at young men, I still think there can be no comparison between the college administrators of fifty years and those of today. It was then the policy of the college to call into its service great men who had achieved eminent distinction in the world without. There was something in the college training of that day, imperfect as were its instruments and slender as were its resources, from which more intellectual strength in the people was begotten than there is in the college training of the present generation. I will not undertake to account for it; but I think it was due in large part to the personality of the instructors. A youth who contemplated with a near and intimate knowledge the large manhood of Josiah Quincy; who listened to the eloquence of James Walker or heard his expositions of the principal systems of ethics or metaphysics; or who sat at the feet of Judge Story as he poured forth the lessons of jurisprudence in a clear and inexhaustible stream,

caught an inspiration which transfigured the very soul of the pupil."

The executives of our schools would do well in choosing teachers, to bear in mind the notable words quoted above. How often is an instructor selected because he is a clear, forceful, inspiring teacher? Is not usually more stress laid upon the number of academic degrees or his reputation as a profound scholar or professional expert? The great need of the whole teaching profession today is more teachers of real ability, strong personality and intellectual enthusiasm.

Adequate Drill in Fundamentals Needed.

The teachers of a generation or two ago were successful not only because of their ability to inspire their students, but particularly as to the wisdom of their instructional methods. Emphasis was laid upon a thorough drill in the fundamental principles of each subject, and the student was required to master them by hard persevering endeavor.

There is a tendency at the present time to use the lecture system which results in the teacher's carrying the burden of the work and the development of a state of mental lassitude in the pupil. President W. T. Foster recently stated: "College courses should necessitate less memorizing and more reasoning. There should be fewer lectures. You can lead a boy to lectures but you cannot make him think—at least not often by this, the easiest of methods of instruction." The most efficient system of instruction is the so-called Socratic or "question and answer" method, which keeps the student on the qui vive and secures a continual exercise of his mental faculties.

Engineering education, if it performs its highest function, should train young men to acquire the professional spirit. This can be accomplished by the teaching of all subjects from a professional point of view. Non-technical studies especially should be taught not abstractly but with relation to their application to engineering science. Mathematics, English, and

economics can be thus taught most effectively by teachers who have had engineering training and experience.

The Evils of Specialization in Instruction.

The rapid growth of applied science has led during the past decade to the establishment in our technical schools of a great variety of specialized courses of study. Into each course of study has been gradually introduced an increasing number of subjects which relate to every phase of the field of science concerned. The curricula thus is arranged to present to the student a vast array of varied and complex knowledge in any single limited field of science. The result of such a course of study is a one-sided training and a superficial conception of some highly specialized phase of one branch of applied science.

Recent experience in teaching graduate students has convinced the speaker that this specialized system of technical instruction gives a general knowledge of many relatively unimportant facts at the expense of a thorough understanding of the few fundamental truths. It is a common occurrence to find a graduate student in structural engineering who does not know thoroughly the theory of the simple beam.

The whole tendency throughout our common school system is to cover a wide range of knowledge in a superficial way. Many of our leading high schools are giving courses in physiography, psychology, and economics; and the business men who employ their graduates justly and bitterly complain that their clerks cannot correctly add up a column of figures or properly compose a simple letter. In our technical schools less time is being given to such important fundamental subjects as English, economics, logic and mathematics, and more time is spent in studying subjects of a purely descriptive character; cramming the student with a vast store of detailed information which he can learn to better advantage later.

The Spirit of the Age.

The characteristics of the present age are great development, constant change, and luxurious standards of living. A

pervading spirit of novelty and innovation leads us to a superficial disregard for the old and a craving for something continually new. The luxuries of today become the necessities of tomorrow. Efficiency is the watchword of the day and in every department of the world's activity there is a striving to accomplish results more quickly and economically. The great industrial army is making "drives" into the fields of new endeavors. All this has bred, especially in the younger generation, a spirit of superficiality and arrogance. The young people of today lack respect for established customs, institutions, and the hard-earned experience and wisdom of their elders. The average college graduate is unwilling to begin at the bottom and ascend the ladder by dint of hard work. His school training has given him the impression that he is a finished product, and should begin life, both in the office and the home, about where his elders are preparing to leave off.

The speaker has been impressed with the fact that our common schools and especially our technical schools have become imbued with the spirit of the age and are trying to *speed up* and *spread out*. Are educators not simply catering to the wishes of those who are least qualified to know what is the proper kind of training to prepare them for their life's work? The average student is inclined to value a subject only in so far as he thinks that he can capitalize it in the future.

The student should be made to understand that it is not so much *what he learns* as *the method by which he learns* that will ensure his success in the world. If he has acquired mental power, the ability to reason, and self-reliance, it is largely immaterial what course he took in a technical school. One of the leading economists of this country at the present time was a graduate civil engineer, and a noted authority on insanity studied to be a geologist. These cases are not exceptional, but are typical of the experience of the alumni of every technical school and show that the technical content of a course of instruction is not of much importance so long as

the mental training is thorough and sustained. Briefly, the problem of engineering education is not one of *technology* but one of *education*.

Proposed Changes in Courses of Study.

The speaker does not believe that technical education is ineffective, but that its development is in a transitional state. This condition has been recognized by many educators, and many attempts have been made to remedy the faults and limitations of our present system. In some colleges the course of study has been extended from four to five or six years; in other institutions a combination course with the academic or arts college has been arranged; and very recently a few colleges have introduced elective technical and non-technical subjects. The speaker has been until recently a very strong advocate of the combination arts and professional course adopted by some of the leading law and medical schools of the country: a baccalaureate degree being required for admission to the professional school. If the profession of engineering is to occupy its proper place among the so-called learned professions of law and medicine, why should not the training required for the former be equivalent to that given for the latter? This question must certainly be answered in the affirmative if we expect to develop in our engineering students those essential qualities of character, initiative, resourcefulness, intellectual power and self-reliance which are required for success in any profession.

The speaker believes that all subjects should be so taught that the knowledge gained may be intelligently applied in practice. The engineering student should study any subject, economics, English, mathematics or applied science, from a technical point of view. This is necessary that the student may thoroughly understand the fundamental principles and their application and may acquire the true professional spirit. Hence it is desirable to introduce early, technical subjects into an engineering course and increase the number towards

the end; the proportion of general studies gradually decreasing. The proportion of the important cultural studies in the curricula should be greater than obtains at present, introducing such subjects as logic, public speaking, commercial law and business relations, etc. Special emphasis should be laid on the teaching of English, not only in studies in English composition and rhetoric but in every study that is included in the curriculum. The top of our present course of study should be cut down and much of the specialization eliminated. The result of this broadening out through the middle and cutting off at the top would be a general course of study of applied science which should give a thorough training in the fundamental principles which the broadly educated engineer must know. It would be proper to give the degree of bachelor of science for the successful completion of such a course.

Those technical schools which have the proper resources, teaching staffs and equipment might offer advanced courses in special branches of applied science. These advanced courses could be profitably taken by those students who had attained marked proficiency in their previous scholastic work or by practicing engineers who might desire to secure special training. Advanced degrees could be appropriately awarded for the successful completion of prescribed courses of study.

The speaker believes that there is an opportunity for a few schools to offer an advanced course in engineering instruction. The purpose of such a course would be the training of teachers for our technical schools. The majority of the teachers in these schools today have come directly into the profession from the technical school or from practice and have little knowledge or understanding of the principles of pedagogy and education. The standards of engineering instruction would doubtless be raised if the teachers were required to have a special training which would be comparable to that required for teachers in the highest rank of the common schools of this country.

In conclusion, the speaker would urge the coöperation of

engineers, engineering teachers and all the members of the great profession of engineering to the elevation of the standards of technical education. Judged by their product, the engineering schools have done and are rendering a splendid service, but recent public opinion seems to indicate that there is room for improvement. The keen competition and rapid development of our civilization require men of action, judgment and intellectual power; and the primary function of our technical schools should not be to disseminate knowledge but to develop character, the ability to reason, and the power to accomplish. An eminent American writer and philosopher said sixteen years ago: "It is not book learning young men need, nor instruction about this and that, but a stiffening of the vertebrae which will cause them to be loyal to a trust, to act promptly, concentrate their energies, do the thing—'carry the message to Garcia!'

"General Garcia is dead but there are other Garcias."

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